INDEX

mercruiser

SERVICE MANUAL

Number 8

MARINE ENGINES
Mercury Marine 4 Cylinder

Printed in U.S.A.

©Brunswick Corporation 1993

90-44553 2-1293

Models Covered in This Manual

MODEL	SERIAL NUMBER
MCM 170 MR	6916779-0A475151
MCM 170 Alpha One	0A475152-0B434940
MCM 165 Alpha One	0B434941-0B774251
MCM 3.7 Litre Alpha One	0B774252 and Above
MCM 190 MR	6917368-0A475551
MCM 190 Alpha One	0A475552-0B436390
MCM 180 Alpha One	0B436391-0B775248
MCM 3.7 Litre LX Alpha One	0B775249 and Above

IMPORTANT: Refer to engine identification, page 1A-2.

NOTICE

Refer to Appropriate Stern Drive service manual for transom assembly and Stern Drive unit repair.

Service Manual Outline

Section 1 - Important Information
A - Important Information
B - Maintenance
C - Troubleshooting

Section 2 - Removal & Installation
A - 4 Cyl. 224 CID (3.7L)

Section 3 - Engine Mechanical
A - 4 Cyl. 224 CID (3.7L)

Section 4 - Electrical Systems
A - Starting System
B - Ignition System
C - Charging Systems
D - Instrumentation
E - Wiring Diagrams

Section 5 - Fuel Systems
A - Fuel Delivery System
B - Fuel Pump
C - Carburetor

Section 6 - Cooling & Exhaust
A - Cooling System
B - Exhaust System

Section 7 - Power Steering
A - Power Steering

Notice

Throughout this publication, "Dangers," "Warnings" and "Cautions" are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. —— Observe them carefully!

These "Safety Alerts" alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus "common sense" operation, are major accident prevention measures.

⚠DANGER
DANGER — Immediate hazards which WILL result in severe personal injury or death.

⚠WARNING
WARNING — Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠CAUTION
CAUTION — Hazards or unsafe practices which could result in minor personal injury of product or property damage.

Notice To Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers, mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

Replacement Parts

⚠WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Engine Mechanical Components

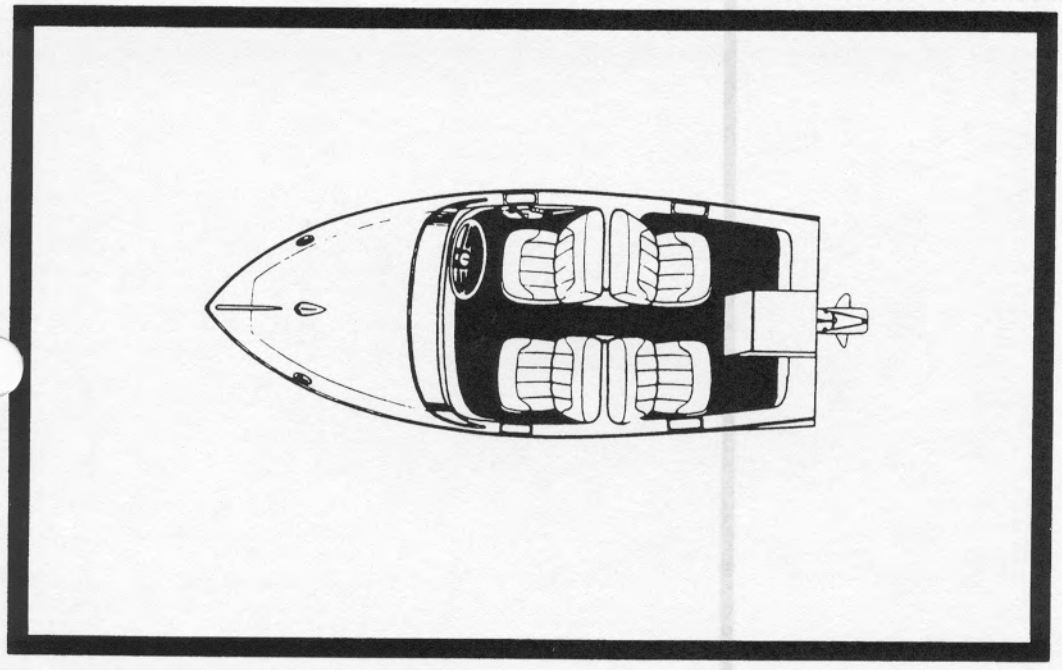
Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durabilty, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

IMPORTANT INFORMATION

1A



mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
How to Use This Manual	1A
Page Numbering	1A
Introduction	1A
Directional Reference	1A
Engine Rotation	1A
Serial Number Location	1A
Engine Identification	1A
Propeller Information	1A
Hi-Performance Boating	1A
Engine 20-Hour Break-In Period	1A
Water Testing New Engines	1A
Boat and Engine Performance	1A
Boat Bottom	1A
Marine Fouling	1A
Weight Distribution	1A
Water in Boat	1A
Elevation and Climate	1A

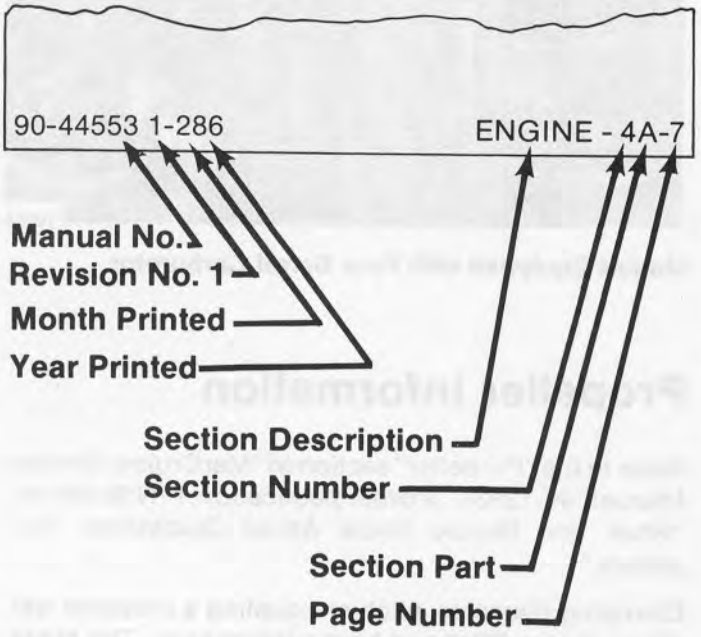
How to Use This Manual

This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



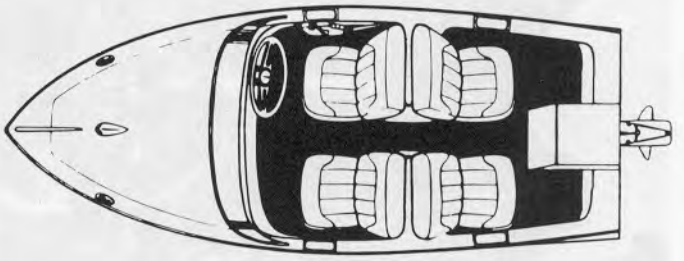
Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the MerCruiser models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

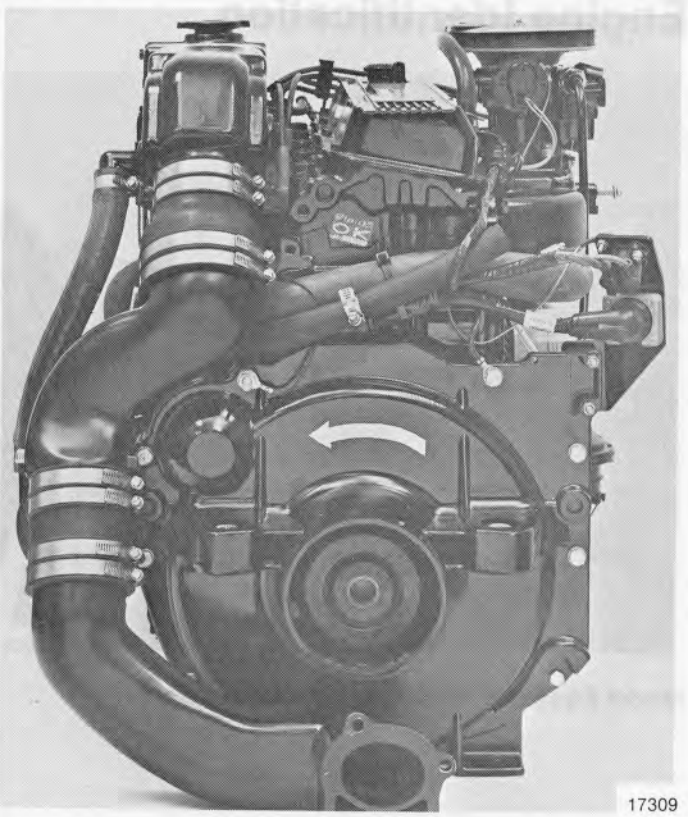
Directional References

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern, looking toward bow.

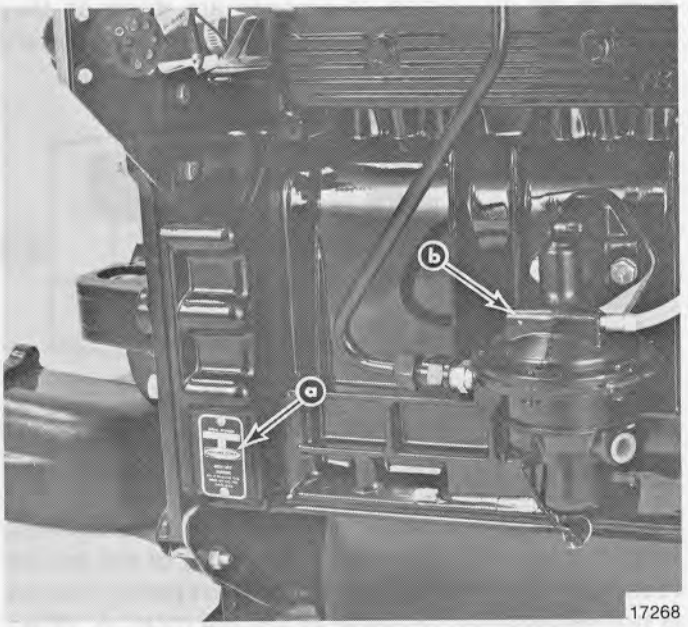


Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern drive end) of the engine looking forward (water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.

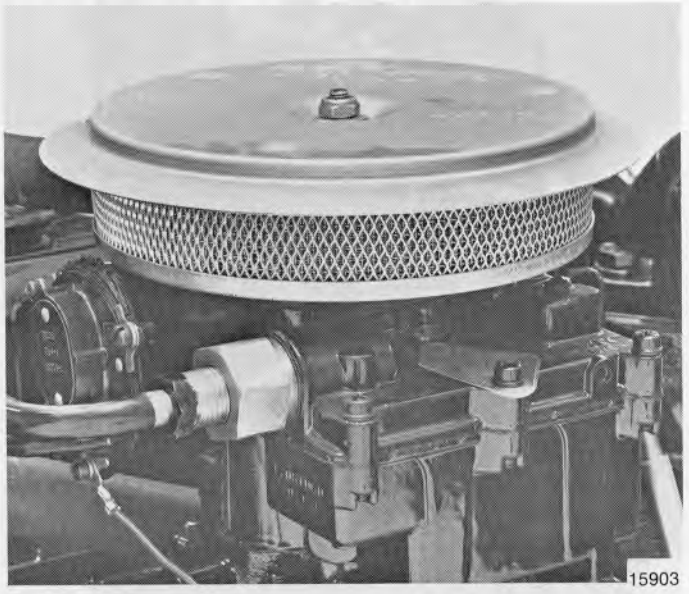


Serial Number Location (All Models)

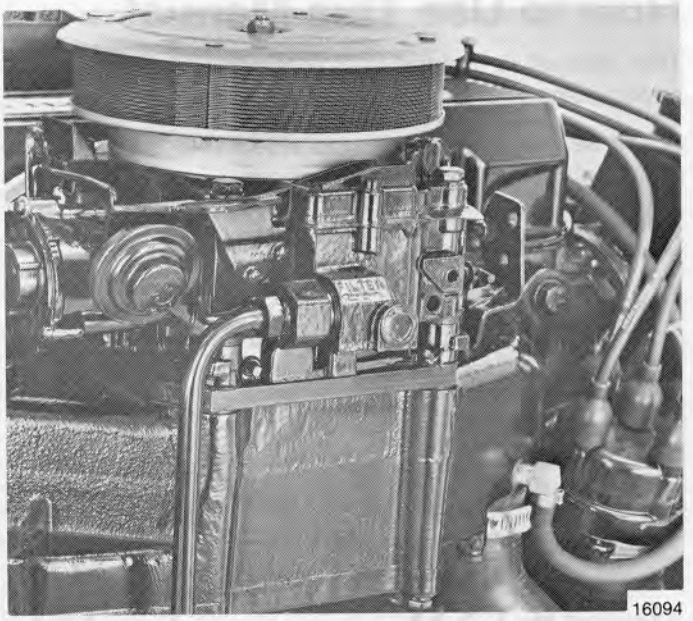


a - Serial Number Plate
b - Fuel Pump

Engine Identification



Model Equipped with Two Barrel Carburetor



Models Equipped with Four Barrel Carburetor

Propeller Information

Refer to the "Propeller" section in "MerCruiser Service Manual" 90-12934, or order publication, P/N 90-86144, "What You Should Know About Quicksilver Propellers."

Changing diameter, pitch or coupling a propeller will affect engine RPM and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller, to allow the boat motor to operate within its specified RPM range at wide open throttle (W.O.T).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that under heavy load engine speed will not fall below specifications.

If engine exceeds the specified RPM, an increase in propeller pitch and/or diameter is required.

If engine is below specified RPM, a decrease in propeller pitch and/or diameter is required.

Normally a change of approximately 300 to 500 RPM will occur for each single pitch change of propeller.

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Hi-Performance Boating

Written by Marine Engineers, order publication P/N 90-86168, entitled "Hi-Performance Boat Operation".

Engine 20-Hour Break-In Period

IMPORTANT: Proper break-in is essential to obtaining minimum oil consumption, maximum engine performance and service.

The first 20 hours of operation is the engine (new or rebuilt) break-in period. During this period, it is extremely important that the engine is operated, as outlined following.

1. Do not operate engine below 1500 RPM for extended periods of time during the first 10 hours. During this period, shift into gear as soon as possible after starting engine and advance throttle so that RPM is above 1500 (provided that conditions permit safe operation at this speed).
2. Do not operate at any one constant speed for extended periods of time.
3. Do not exceed 3/4 of full throttle during the first 10 hours of operation. During the next 10 hours, occasional operation at full throttle (5 minutes at-a-time maximum) is permissible.
4. Avoid full throttle acceleration from stopped position.
5. Do not operate at full throttle until engine reaches normal operating temperature.
6. Observe instrumentation carefully. If an abnormal reading occurs, stop engine immediately and determine cause.
7. Frequently check crankcase oil level and add oil, if necessary. It is normal for oil consumption to be somewhat high during the break-in period.
8. At end of 20-hour break-in period, drain break-in oil from crankcase and replace oil filter. Fill crankcase with correct grade and viscosity oil.

Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruiser engines, or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

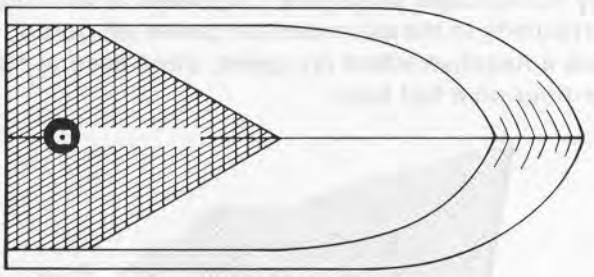
1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

IMPORTANT: Do not run at maximum RPM for more than 2 minutes.

Boat and Engine Performance

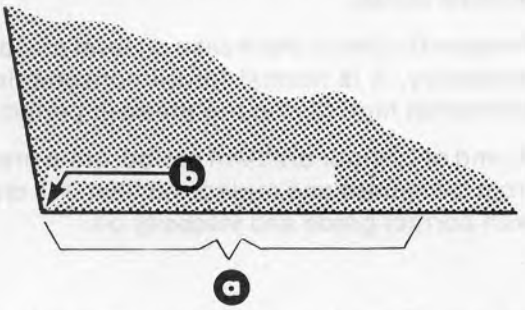
Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5m).



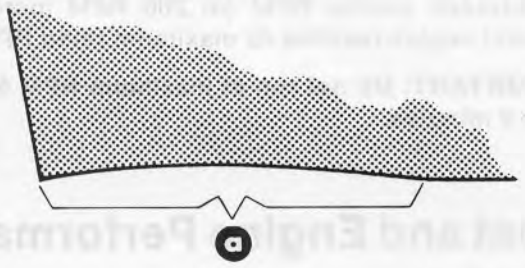
a - Critical Bottom Area

For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



a - Flat
b - Sharp Corner

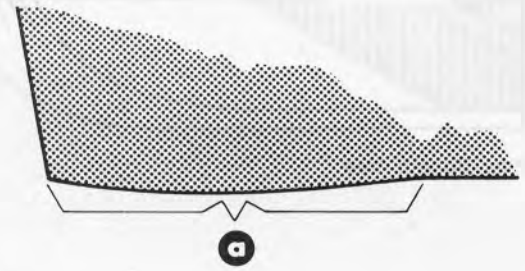
The bottom is referred to as having a "hook" if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed, but it helps planing and reduces any porpoising (rythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook can also be caused by not trailering or storing the boat with support directly under the transom.



a - Hook

A "rocker" is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles-per-hour on a fast boat.



a - Rocker

Marine Fouling

Fouling is an unwanted buildup (usually animal-vegetable-derived) occuring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. So it's important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as anti-fouling paint, will reduce the rate of bottom fouling. However, due to the fact that drive units (outboard or stern drive) are made primarily of aluminum, be sure to select an anti-fouling paint having a copper-free, organo-tin base. The BIS (Tri Butyl Tin) Adipate (TBTA) base paint will not set up a galvanic corrosion "cell" as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instruction, it is also very effective.

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight — cargo and passengers — should be as far aft as possible to allow the bow to come up to a more efficient angle (3° to 5°). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

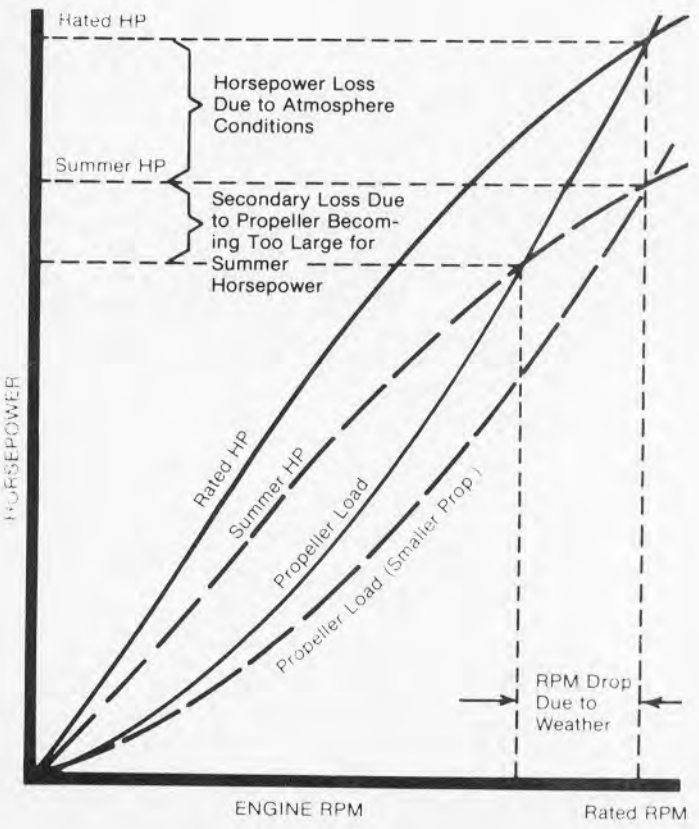
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool, dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip. (See chart)

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.



Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight — cargo and passengers — should be as far aft as possible to allow the bow to come up to a more efficient angle (3° to 5°). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

When a boat loses performance, check bilge for water. Water can add considerable weight to the boat thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool, dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip. (See chart)

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

MAINTENANCE

1

B

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation
Engine Crankcase Oil - Check level	●		
Closed Cooling Coolant - Check coolant level	●		
Remote Control and Steering System - Check for proper operation	●		
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	●		
Ignition System - Check timing and adjust, if necessary		■	
Crankcase Oil and Oil Filter - Change		●	

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Maintenance Schedule	1B-1
Fluid Capacities	1B-3
Specifications	1B-3
Fuel, Oil, Fluid and Coolant Specifications	1B-4
Fuel	1B-4
No Lead Gasoline/Alcohol Blends	1B-4
Lead	1B-4
Gasoline/Alcohol Blends	1B-4
Effects of Gasoline/Alcohol Blends on Marine Engines	1B-5
Boat/Motor Storage	1B-5
Winter Storage	1B-5
Warranty	1B-5
Continuing Evaluations	1B-5
Test for Alcohol Content in Gasoline	1B-5
Procedure	1B-5
Crankcase Oil	1B-6
Power Steering	1B-7
Coolant	1B-7
Maintaining Crankcase Oil Level	1B-7
Overfilled Engine Crankcase	1B-7
Checking Engine Oil Level/Filling	1B-7
Changing Oil and Filter	1B-7
Maintaining Power Steering Fluid Level	1B-8
Filling and Bleeding Power Steering System	1B-9
Maintaining Coolant Level	1B-10
Flushing Cooling System Seawater Section	1B-10
Lubrication	1B-11
Throttle Cable	1B-11
Shift Cable	1B-11
Engine Coupling	1B-12
U-Joint Splines	1B-12
Out of Season Storage	1B-12
Precautions	1B-12
Layup	1B-13
Recommissioning	1B-13

MAINTENANCE CHART

Only perform maintenance which applies to your particular power package.

● = To Be Performed by Owner
■ = To Be Performed by an Authorized MerCruiser Dealer
F = Freshwater Areas Only
S = Saltwater Areas Only

TASK	INTERVAL			
Location and Service	Weekly	Every 50 Hours or 60 Days	Every 100 Hours or 120 Days	At Least Once a Year
Engine Crankcase Oil - Check level	●			
Closed Cooling Coolant - Check level	●			
Ignition System - Check timing; adjust if needed				■
Crankcase Oil and Oil Filter - Change			■	■
Power Steering Fluid - Check level	●			
Stern Drive Unit Oil - Check level	●			
Steering System - Lubricate and inspect for loose, damaged or missing parts		S■	F■	■
Battery - Check level and inspect for damage	●			
Electrical System (Entire) - Check for loose or damaged wiring		S■	F■	■
Fuel Pump Sight Tube - Check for fuel	●			
Cooling System Hoses and Clamps - Inspect for damage and deterioration. Check clamps for tightness		S■	F■	■
Engine Exhaust System- Inspect for damage, deterioration and restrictions. Check clamps for tightness		S■	F■	■
Drive Belts (All) - Inspect condition and check tension			●	●
Ignition System - Clean and inspect condition			■	■
Flame Arrestor and Crankcase Ventilation Hose - Clean and inspect			■	■
Continuity Circuit - Check components for loose connections, broken or frayed wires		S■	F■	■

MAINTENANCE CHART
(Continued)

TASK	INTERVAL			
Location and Service	Weekly	Every 50 Hours or 60 Days	Every 100 Hours or 120 Days	At Least Once a Year
Shift and Throttle Cable and Linkage - Lubricate and inspect for loose, damaged or missing parts		S■	F■	■
Power Trim Pump Oil - Check level	●			
Stern Drive Unit Oil - Change			■	■
Propeller Shaft - Lubricate		S●	F●	●
Transom Gimbal Housing Assembly Swivel Shaft and Pin, Hinge Pins and Gimbal Bearing - Lubricate		S■	F■	■
Engine Coupling, Stern Drive Unit Universal Joint and Shaft Splines - Lubricate			■	■
Engine Alignment - Check			■	■
Fuel Filters - Replace				■
Power Package Exterior Surfaces - Clean and paint				●
Steering Head and Remote Control - Inspect and lubricate				■
Quicksilver MerCathode® System - Test output				■
Closed Cooling Coolant - Test for alkalinity				■
Heat Exchanger - Clean seawater section				■
Cooling System - Flush seawater section	S● AFTER USE EACH DAY			
Power Package Exterior Surfaces - Spray with rust preventive		S●	F●	●
Closed Cooling Coolant - Replace	■ EVERY 2 YEARS			
Zinc Alloy Trim Tab, Anodic Heads, Anodic Plate and Quicksilver Anticorrosion Anode Kit (Optional) - Inspect for erosion	●			
Gear Housing Water Pickups - Check for marine growth or debris	●			
Carburetor - Adjust				■

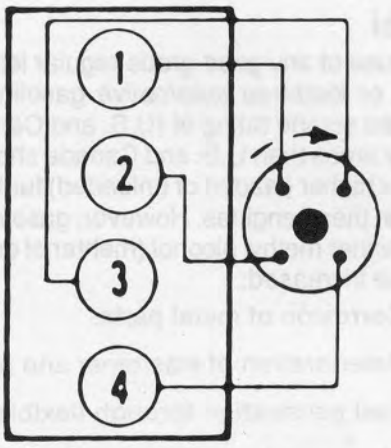
Fluid Capacities

NOTICE

Capacities are approximate fluid measures.

Model	165-170 3.7	180-190 3.7LX
Crankcase (with Filter)	5-1/2 U.S. Qts. (5.2 L)	6-1/2 U.S. Qts. (6.1 L)
Closed Cooling System	11 U.S. Qts. (10.4 L)	

L.H. ROTATION
FRONT



Firing Order
1-3-4-2

Specifications

Left-Hand Rotation
Engine Firing Order

MODEL	165/3.7 Litre	170	180/3.7 Litre LX	190
Horsepower (Kilowatts)	165 (123 kw)	170 (127 kw)	180 (135 kw)	190 (142 kw)
Displacement	224 cu. in. (3.7 L)			
Engine Type and No. of Cylinders	In-Line 4 Cylinder			
Bore	4.36 in. (110.7mm)			
Stroke	3.75 in. (95.3mm)			
Compression Ratio	8.8:1			
Compression Pressure	150 psi (1035 kPa)			
Point Gap	.022 in. (56mm)			
Point Dwell	28° - 34°			
Point Spring Tension	19-23 oz. (538-652 g)			
Spark Plug Type	Champion RV9YC, AC R42TS or Quicksilver 33-75339			
Spark Plug Gap	.035 in. (0.9mm)			
Timing at Idle RPM	4° BTDC			
Max. RPM @ W.O.T.	4200-4600		4400-4800	
Idle RPM in Forward Gear	650-700			
Firing Order	1-3-4-2			
Fuel Pump Pressure (@ 1000 RPM)	3-6 psi (21-41 kPa)			
Electrical System	12-Volt Negative Ground			
Oil Pressure @ 2000 RPM	Minimum 15 psi (103 kPa)			
Thermostat	160° F (71° C)			
Fuel Requirements	Refer to "Fuel Specifications," see "Index"			
Minimum Battery Requirement	450 CCA / 90 Ah			

Fuel, Oil, Fluid and Coolant Specifications

Fuel

The use of any good grade regular leaded, premium, low-lead or lead-free automotive gasolines with a minimum posted octane rating of (U.S. and Canada) 87 (R+M/2) all other areas than U.S. and Canada should use 92 RON rating or higher (leaded or unleaded) fuels, are satisfactoy for use in these engines. However, gasolines containing alcohol, either methyl alcohol (mehtanol or theyl (ethanol) may cause increased:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Fuel permeation through flexible fuel lines.
- Wear and damage of internal engine parts.
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, primer bulbs, fittings, fuel filters and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration necessitates replacement before further engine operation.

Because of the possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only alcohol-containing fuel is available, or if the presence of alcohol is unknown, then increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided. Long periods of storage, common to boats, create unique problems: In cars, alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

⚠CAUTION

Use of improper gasoline can damage the engine seriously. Engine damage that results from use of improper gasoline is considered misuse of the engine and is not covered under MerCruiser Warranty.

GASOLINE/ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially **METHANOL**. They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine engines. **METHANOL** is more severe in its bad effects than is **ETHANOL**. Alcohol is also more severe in older engines since newer engines have materials which are more resistant to alcohol.

EFFECTS OF GASOLINE/ALCOHOL BLENDS ON MARINE ENGINES

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to fuel tank failure.

Alcohol containing fuels will absorb moisture from the air. At first, this moisture will remain in solution, but once the water content of the fuel has built up to about one-half of one percent, it will separate out, (phase separation) bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, engines can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT/MOTOR STORAGE

When operating a MerCruiser on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

It is also recommended to coat the internal engine parts with Quicksilver Storage Seal. Follow the directions on the container. This coating will reduce possibilities of internal parts becoming rusted from moisture accumulation during storage.

WARRANTY

Performance problems, fuel system or other damage resulting from the use of gasoline-alcohol blended fuels is not the responsibility of Mercury Marine and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline blended with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is or can be provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space; then, cap the container. The proportions of fuel to water are not critical, but there should be 2-3 times as much fuel as water.
3. Shake container vigorously and allow it to sit upright for up to about 3-5 minutes. **If the volume of water appears to have increased, alcohol is present.** If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

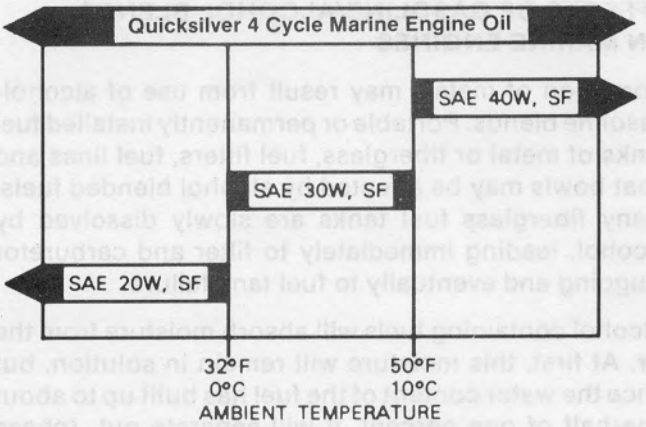
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SF, may be used.

The chart below is a guide to crankcase oil selection. Oil filter should always be changed with oil.

In those areas where recommended straight weight oil is not available, a multi-viscosity 20W-40 (SF) or, as a second but less preferable choice, 20W-50 (SF) may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than 20W-40 or 20W-50), low quality oils or oils which contain solid additives specifically are not recommended.



Power Steering

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid automatic transmission fluid (ATF) Dexron or Dexron II in Power Steering System.

Coolant

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Any brand of permanent type anti-freeze solution that is made for aluminum component engines can be used in aluminum Mercury Marine 224 CID (3.7L) engines. DO NOT MIX the new anti-freeze solution with the old solution or it will cause small particles to form in the coolant. These small particles can settle in the heat exchanger and restrict coolant flow. Drain and flush the old anti-freeze solution from the closed cooling system.

Maintaining Crankcase Oil Level

Overfilled Engine Crankcase

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter", on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down". This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the "ADD" mark and the "FULL" mark on the dipstick. To ensure that you are not getting "false reading", make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, OR
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase, if engine has just been run or oil has just been added.

Checking Engine Oil Level/Filling

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick. Wipe clean and reinstall. Push dipstick all-the-way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks.
6. If oil level is below "ADD" mark, proceed to 7 and 8.
7. Remove oil filler cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, the "FULL" mark on dipstick.

Changing Oil and Filter

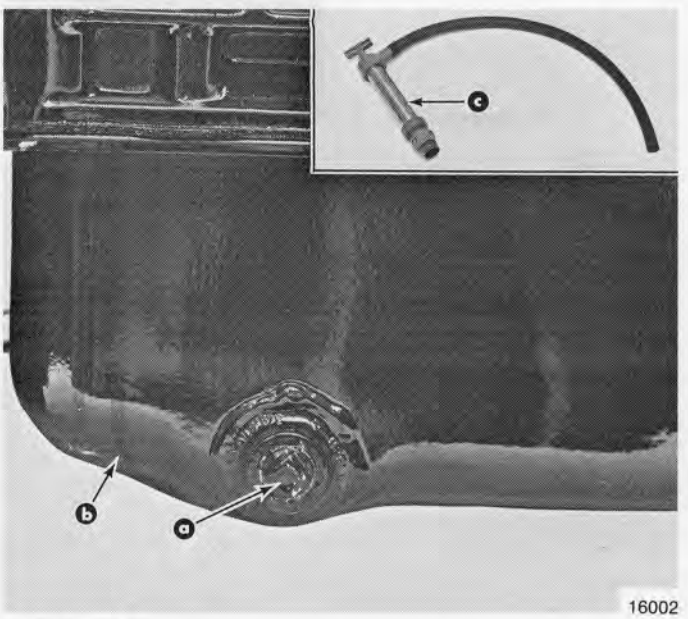
1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan.

NOTE: If drain plug is not accessible because of boat construction, oil may be removed thru dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)

4. After oil has drained completley, reinstall drain plug and tighten securely.



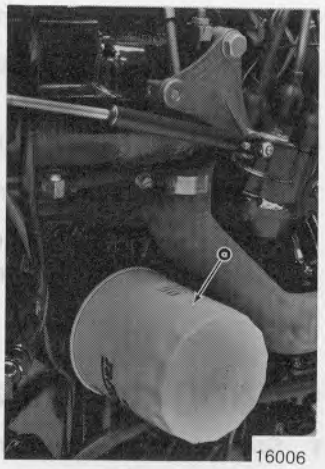
16002

a - Drain Plug
b - Oil Pan
c - Quicksilver Crankcase Oil Pump

5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install new filter. Tighten filter securely (following filter manufacturer's instructions). But do not overtighten.
7. Fill crankcase with oil.

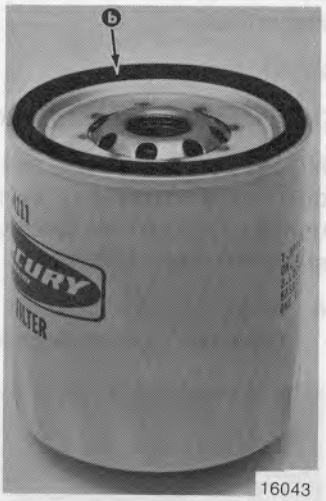
a - Oil Filter

MCM 165/170/3.7L Engine



a - Oil Filter

MCM 180/190/3.7LX Engine



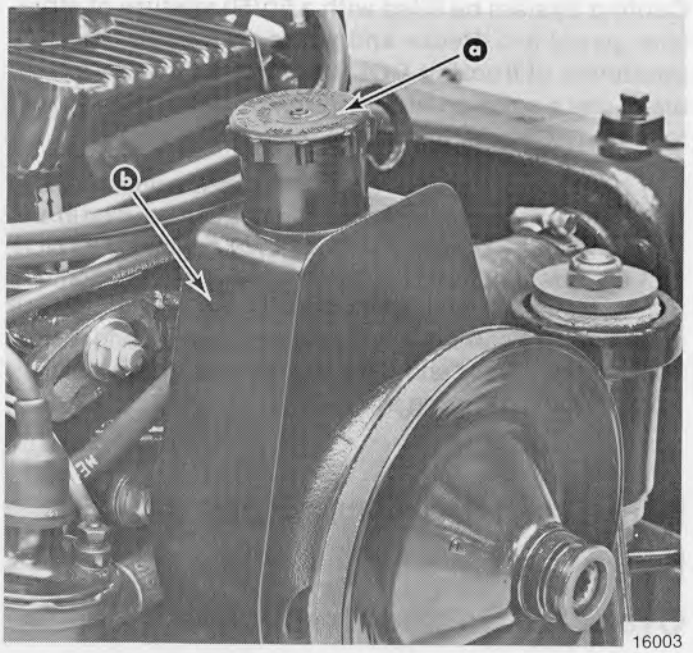
b - Sealing Ring

Maintaining Power Steering Pump Fluid Level

IMPORTANT: Use only Quicksilver Power Trim and Steering fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

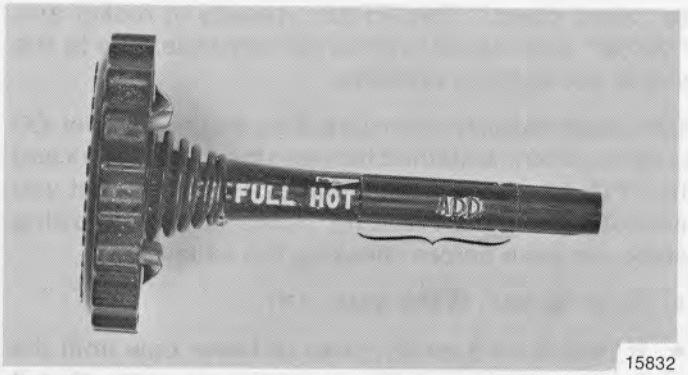
WITH ENGINE WARM FROM OPERATION

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.



a - Fill Cap/Dipstick
b - Pump

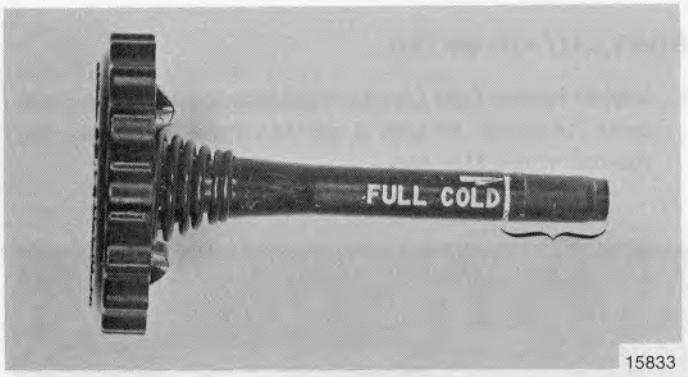
3. Level should be between the "FULL HOT" mark and "ADD" mark on dipstick.



4. If level is low (below "ADD" mark), but fluid is still visible in pump reservoir, add required amount of fluid thru fill cap opening, to bring level up to "FULL HOT" mark on dipstick - do not overfill.
5. If fluid is not visible in reservoir, a leak exists in Power Steering System.

WITH ENGINE COLD

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.
3. Level should be between "FULL COLD" mark and bottom of dipstick.



15833

4. If fluid level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of fluid, thru fill cap opening, to bring level up to "FULL COLD" mark on dipstick - Do not overfill.
5. If fluid is not visible in reservoir, a leak exists in Power Steering System.

Filling and Bleeding Power Steering System

IMPORTANT: Power Steering system must be filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering sytem to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Check fluid level with fill cap/dipstick. Add fluid as required, to bring level up to "FULL-COLD" mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then, recheck fluid level and add fluid, if necessary.
3. Install fill cap/dipstick.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump in stern drive unit, or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse; then, check fluid level and add fluid, as required, to bring level up to "FULL-HOT" mark on dipstick. Do not overfill. Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and Power Steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Maintaining Coolant Level

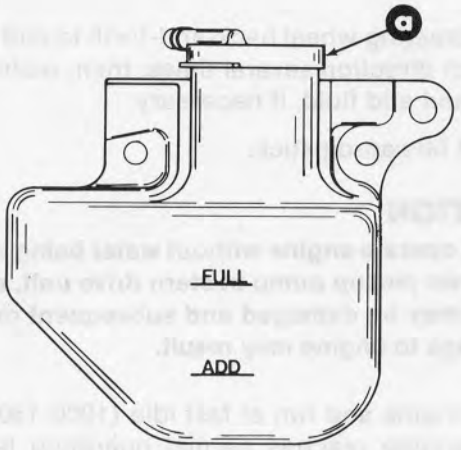
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly; then, push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1 in. (25mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stop on filler neck.

2. Coolant level should be between the "ADD" and "FULL" mark on coolant recovery reservoir with engine at normal operating temperature.



193-HR

a - Fill Cap

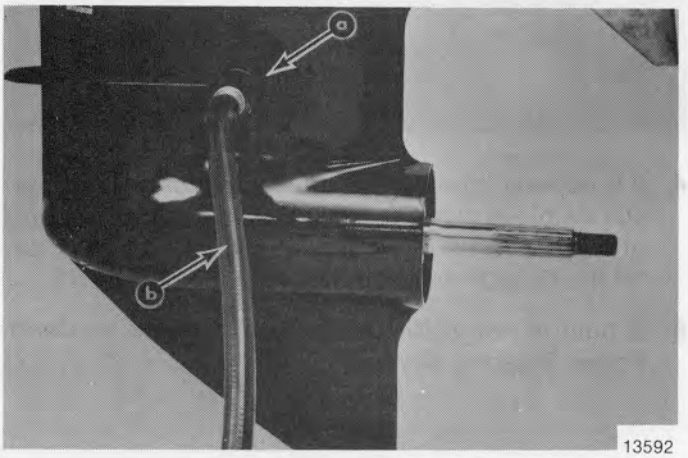
Flushing Cooling System Seawater Section

⚠CAUTION

DO NOT run engine above 1500 RPM when flushing, as suction created by seawater pickup pump in drive unit may collapse garden hose and cause engine and/or drive unit to overheat.

BOAT OUT-OF-WATER

1. Install Flush-Test Device over water pickup holes in gear housing. Attach a garden hose between the device and water tap.



13592

a - Flushing Device
b - Hose

2. Partially open water tap (approximately 1/2 maximum capacity). Do not use full city water pressure.

⚠WARNING

When flushing cooling system, be certain that area in vicinity of propeller is clear and that no person(s) is nearby. As a precautionary measure, it is recommended that propeller be removed.

3. Place remote control in neutral, idle speed position, and start engine.
4. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear; then, stop engine.
5. Shut off water tap. Remove Flush-Test-Device and garden hose.

BOAT IN-THE-WATER

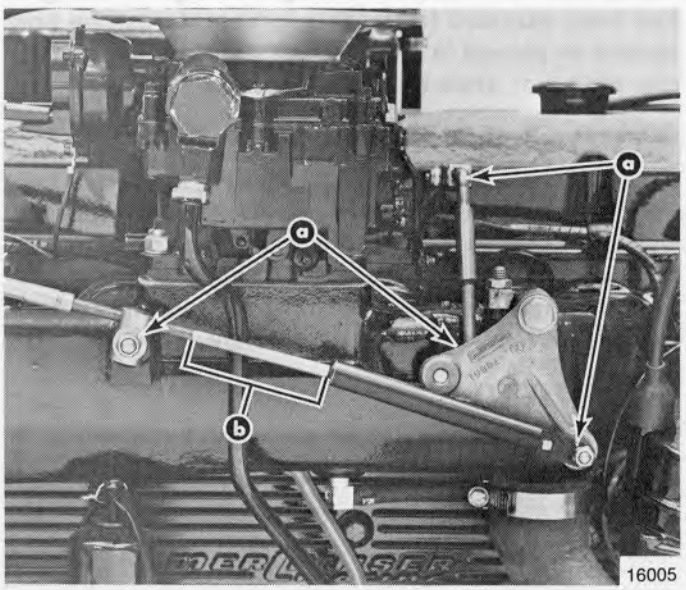
1. Raise drive unit to full "Up" position.
2. Install Flush-Test Device over water pickup holes in gear housing. Attach a garden hose between the device and water tap.
3. Lower drive unit to full "In" position.
4. Follow Steps 2 thru 4 under "Boat Out-of-Water".
5. Shut-off water tap.
6. Raise drive unit to full "Up" position - Remove Flush-Test Device and garden hose.

Lubrication

Throttle Cable

1. Lubricate pivot points with SAE 30 engine oil.
2. Lubricate cable end guide contact surfaces with Quicksilver 2-4-C Marine Lubricant.

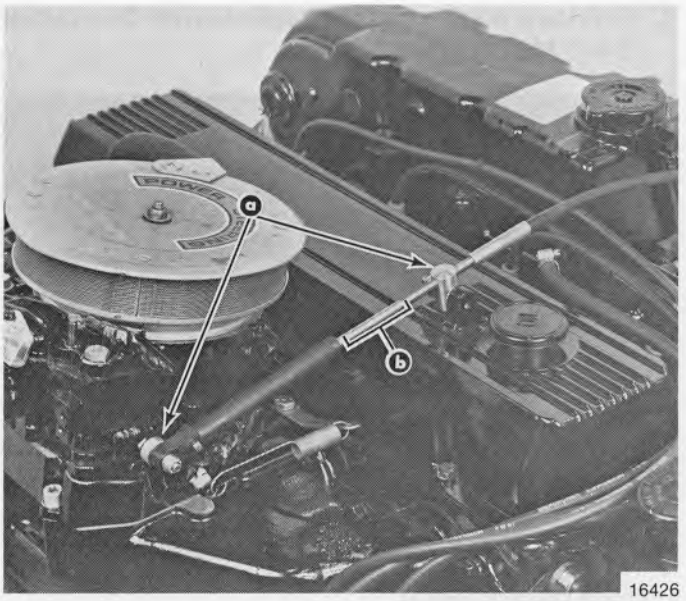
MODEL 170



16005

a - Pivot Points
b - Guide Contact Surface

MODEL 190

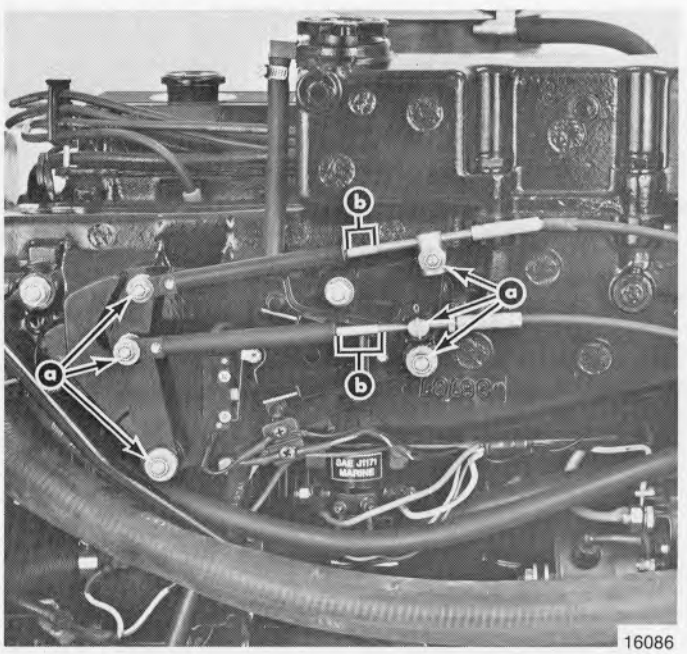


16426

a - Pivot Points
b - Guide Contact Surface

Shift Cable

1. Lubricate pivot points with SAE 30 engine oil.
2. Lubricate cable end guide contact surfaces with Quicksilver 2-4-C Marine Lubricant.

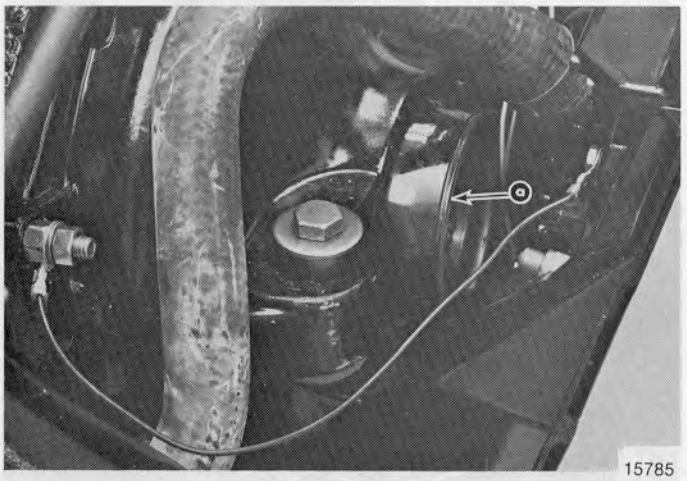


16086

a - Pivot Points
b - Guide Contact Surface

Engine Coupling

1. Lubricate engine coupling splines with Quicksilver 2-4-C Marine Lubricant.



a - Engine Coupling Splines

U-Joint Splines

1. Lubricate U-Joint shaft splines and "O" rings with Quicksilver 2-4-C Marine Lubricant. Refer to "MerCruiser Stern Drive Service Manual.

Out-of-Season Storage

Precautions

⚠WARNING

Be careful while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF" and do not smoke or allow sources of spark and/or open flames in the area.

⚠WARNING

To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION

Seawater section of cooling system must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine. If engine has been exposed to freezing temperatures, the boat should be placed in a warm area before attempting to run engine or drain cooling system.

⚠CAUTION

Closed Cooling section of cooling system must be kept filled with a solution of ethylene glycol anti-freeze and water (mixed to anti-freeze manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). Seawater section, however, must be drained completely.

⚠CAUTION

A discharged battery can be damaged by freezing.

Layup

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Marine Fuel System Treatment and Stabilizer to treat the gasoline.

IMPORTANT: If boat is to be placed in storage (with fuel containing alcohol in fuel tanks), carburetors must be run dry at idle RPM. Fuel tanks should be drained completely and Marine Fuel System Treatment and Stabilizer added to any fuel remaining in the tank. Also, refer to "Fuel Requirements"; see "Index."

2. Replace all fuel filters.
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to bring it up to normal operating temperature; shut off engine and change oil and filter.
5. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system.
6. Remove flame arrestor assembly and restart engine. While operating engine at fast idle (1000-1500 RPM), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal Rust Inhibitor or SAE 20 SE engine oil into carburetor bores. Stall engine by squirting last 2 ounces (57 grams) of Storage Seal or oil rapidly into carburetor. Turn ignition "OFF."
7. Close fuel shut off valve, if so equipped.
8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items outlined in "Lubrication".
10. Drain seawater section of cooling system.
11. Closed Cooling System, test coolant in closed cooling section to ensure that it will withstand lowest temperature expected during storage.
12. Service batteries.
13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion or a good grade of wax guard.
14. For Stern Drive Unit, refer to "Stern Drive Manual".

Recommissioning

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are in and tight.
2. Inspect all drive belts.
3. Check engine alignment.
4. Perform ALL lubrication and maintenance specified for completion under "At Least Once Each Year" in "Maintenance Chart," except items which were performed at time of engine layup.
5. Install Stern Drive unit (refer to "Stern Drive Manual").

⚠CAUTION

When installing battery (in next step), be sure to connect negative (grounded) battery cable to negative (-) battery terminal and positive battery cable to positive (+) terminal. If battery cables are reversed, damage to electrical system WILL result.

6. Install fully-charged battery. Clean battery cable clamps and terminals and reconnect cables. Be sure to tighten clamps securely. Apply a thin coat of petroleum base grease to clamps and terminals to help retard corrosion.
7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check fuel pump sight tube.
10. Check steering system and shift and throttle control for proper operation.

TROUBLESHOOTING

1

C

CAUSE	SPECIA
1. Moisture on ignition components	1. Distributor cap or spa
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interruptor switch	5. Disconnect tachom
5. Shorted tachometer	
6. Ignition timing	7. Fouled, burned, cr
7. Spark plugs	8. Faulty insulation,
8. Spark plug wires	
9. Cracked or dirty distributor cap	10. Check compone
10. Faulty ignition components	11. Synchronizers m (parallel circuit)
11. Engine synchronizer (if equipped) hooked up in series on ignition wire (dual engines only)	

NOTICE
Refer to "Precautions", BEFORE proceeding with troubleshooting.

INDEX

	Page
Precautions	1C-1
Used Spark Plug Analysis	1C-1
Spark Plug Analysis	1C-1
Poor Boat Performance and/or Poor Maneuverability	1C-5
Improper Full Throttle Engine RPM	1C-5
RPM Too High	1C-5
RPM Too Low	1C-5
Engine Cranks Over But Will Not Start or Starts Hard	1C-6
Conventional Ignition (No Spark)	1C-6
Fuel System Rich	1C-7
Fuel System Lean	1C-7
Miscellaneous	1C-7
Engine Will Not Crank Over	1C-8
Charging System Inoperative	1C-8
Noisy Alternator	1C-8
Instrumentation Malfunction	1C-8
Radio Noise	1C-9
Poor Fuel Economy	1C-9
Carburetor Malfunctions	1C-10
Engine Runs Poorly at Idle	1C-11
Engine Acceleration Is Poor	1C-11
Engine Runs Poorly at High RPM	1C-12
Troubleshooting with Vacuum Gauge	1C-12
Engine Noise	1C-13
Important Information	1C-13
Valve Cove Area	1C-13
Cylinder Area	1C-13
Camshaft Area	1C-14
Crankshaft Area	1C-14
Miscellaneous	1C-15
Oil Pressure	1C-16
Important Information	1C-16
Low Oil Pressure	1C-17
High Oil Pressure	1C-17
Excessive Oil Consumption	1C-18
Water in Engine	1C-19
Important Information	1C-19
Water on Top of Pistons	1C-19
Water in Crankcase Oil	1C-19
Engine Overheats (Mechanical)	1C-20
Engine Overheats (Cooling System)	1C-21
Insufficient Water Flow from Drive Seawater Pickup Pump	1C-22
Power Steering	1C-23
Poor, Erratic or No Assist	1C-23
Noisy Pump	1C-23
Fluid Leaks	1C-23

PRECAUTIONS

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION
DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out-of-water, if instructions, under "Running Engine with Boat Out-of-the-Water", following, are completed.

⚠WARNING
When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠WARNING
Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE.

⚠WARNING
DO NOT leave helm unattended while performing idle speed adjustment.

USED SPARK PLUG ANALYSIS

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

A. Remove any oil deposits with solvent and dry plugs thoroughly.

B. Open electrode gap wide enough to permit cleaning and filing.

C. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.

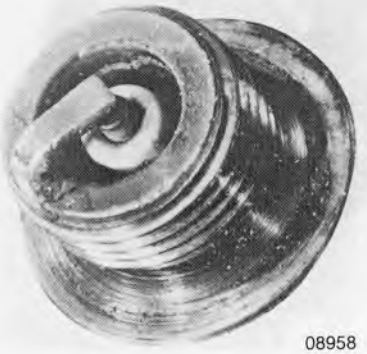
D. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.

E. Reset gap to specifications by bending only side electrode with proper tool.

SPARK PLUG ANALYSIS

NORMAL CONDITION

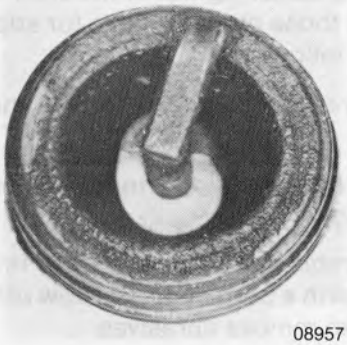
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.



08958

CHIPPED INSULATOR

Chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.



08957

WET FOULING (OIL DEPOSITS)

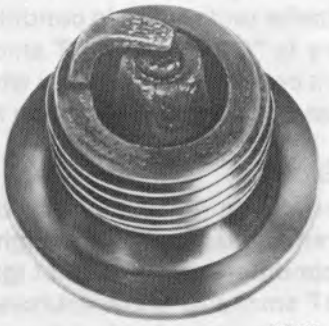
Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.

08958

COLD FOULING

Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If only one or two plugs in set are fouled, however, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and regap) plugs and reinstall.



08958

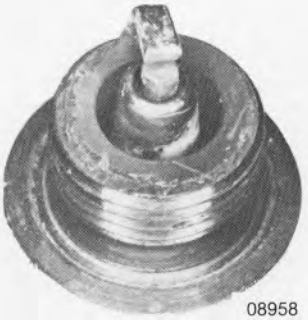
OVERHEATING

Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.

08957

HIGH SPEED GLAZING

Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition re-occurs, use colder heat range plug and service plugs more frequently.



08958

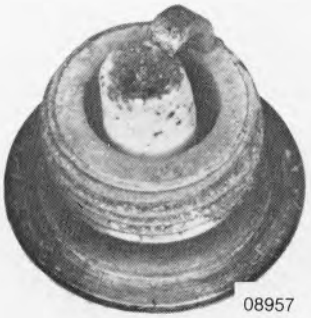
SCAVENGER DEPOSITS

Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is a normal appearance with certain branded fuels. Accumulation on ground electrode and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and regap) and reinstalled.

08958

PRE-IGNITION DAMAGE

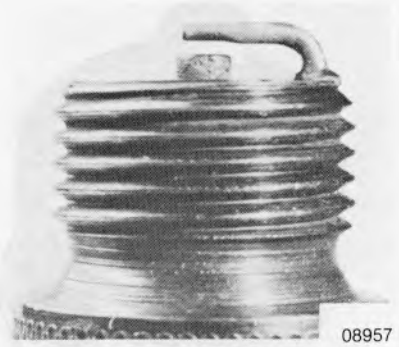
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.



08957

REVERSED COIL POLARITY

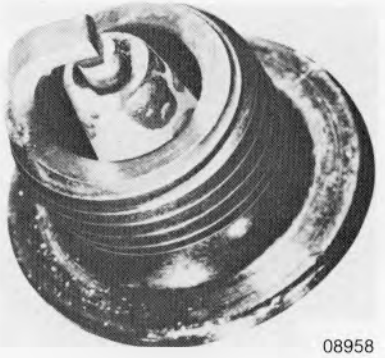
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



08957

SPLASHED DEPOSITS

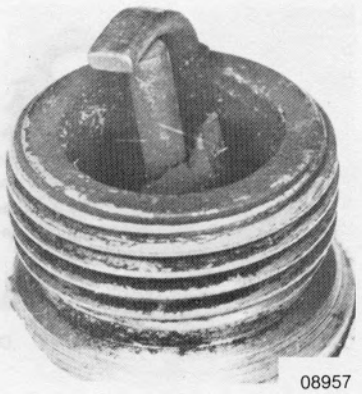
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and reinstall.



08958

MECHANICAL DAMAGE

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust manifold to prevent further damage.



08957

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

POOR BOAT PERFORMANCE and/or POOR MANEUVERABILITY

SYMPTOM	CAUSE
1. Bow too low	1. A. Improper drive unit trim angle B. Improper weight distribution C. Boat is underpowered D. Permanent or power hook in boat bottom E. False bottom full of water F. Improperly adjusted trim tabs (after planes)
2. Bow too high	2. A. Improper drive unit trim angle B. Propeller pitch too great C. Dirty boat bottom (marine growth) D. Poor running engine E. Improper weight distribution F. Rocker in boat bottom G. False bottom full of water H. Improperly adjusted trim tabs (after planes)
3. Propeller ventilating	3. A. Drive unit installed too high on transom B. Dirty or rough boat bottom C. Damaged propeller, pitch too small, diameter too small D. Keel located too close to propeller or too deep in the water E. Water pick-up or accessories located too close to propeller F. Hook in boat bottom G. Propeller plugged up with weeds

IMPROPER FULL THROTTLE ENGINE RPM

RPM TOO HIGH

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged, pitch too low, diameter too small, propeller hub slipping.
2. Boat	2. Water pick-up or accessories mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom, wrong gear ratio.
3. Operation	3. Unit trimmed out too far.
4. Engine coupler slipping	

RPM TOO LOW

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged, pitch too great, diameter too great.
2. Boat	2. Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
3. Operation	3. Unit trimmed in too far.

ENGINE CRANKS OVER BUT WILL NOT START OR STARTS HARD

1. First, determine which engine system is causing the problem. To make an engine run basic components - fuel, spark (ignition), and compression are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Determine if there is fuel present by looking down carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure the plugs are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is mechanically OK.

CONVENTIONAL IGNITION (NO SPARK)

CAUSE	SPECIAL INFORMATION
1. Moisture on ignition components	1. Distributor cap or spark plug leads arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	3. May run in start position and lose spark in the run position.
4. Shift interruptor switch	
5. Shorted tachometer	5. Disconnect tachometer and try again.
6. Ignition timing	6. May crank over hard, backfire, or try to run backwards
7. Faulty ignition resistor wire or bypass wire	
8. Ignition points improperly gapped, burned or dirty	
9. Spark plugs	9. Fouled, burned, cracked porcelain
10. Spark plug wires	10. Faulty insulation, broken wires
11. Cracked or dirty distributor cap or rotor	
12. Coil	
13. Condenser	

FUEL SYSTEM RICH

CAUSE	SPECIAL INFORMATION
1. Warm engine carburetor percolation	1. Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
2. Clogged flame arrestor	
3. Automatic choke not opening	
4. Float adjustment	
5. Float leaks or is saturated with fuel	
6. Needle and seat leaking	
7. Carburetor gaskets leaking	
8. Excessive fuel pump pressure	8. Unseats needle and seat
9. Cracked or porous carburetor body	

FUEL SYSTEM LEAN

CAUSE	SPECIAL INFORMATION
1. Empty fuel tank	
2. Fuel shut off valve closed (if equipped)	
3. Anti-siphon valve stuck closed (if equipped)	
4. Vapor lock	4. Engine will not start after warm engine shut down
5. Automatic choke	5. Stuck open, wrong adjustment
6. Fuel tank vent plugged	6. Engine will start initially. After a short time of running, engine will stall and will not restart for a period of time. Can varify it is a vent problem by running engine with filler cap loose. Filler cap will act as a vent.
7. Air leak on suction side of fuel system	7. Sucks air into fuel system reducing fuel volume
8. Plugged or pinched fuel line	
9. Fuel pump	9. Low pump pressure

MISCELLANEOUS

CAUSE	SPECIAL INFORMATION
1. Low grade or stale fuel	
2. Water in fuel	
3. Vacuum leak	
4. Low compression	4. Worn valves, rings, cylinder, or head gasket
5. Valve timing incorrect	5. Timing chain or gears jumped or improperly installed

ENGINE WILL NOT CRANK OVER

CAUSE	SPECIAL INFORMATION
1. Control lever not in neutral position	
2. Battery charge low; damaged wiring; loose electrical connections	
3. Blown fuse at starter motor	3. On early models with red wire going to fuse on starter terminal.
4. Circuit breaker tripped	
5. Ignition switch	
6. Slave solenoid	
7. Faulty neutral start safety switch	7. Open circuit.
8. Starter solenoid	
9. Starter motor	

CHARGING SYSTEM INOPERATIVE

CAUSE	SPECIAL INFORMATION
1. Loose or broken drive belt	
2. Engine RPM too low on initial start	2. Rev engine to 1500 RPM
3. Loose or corroded electrical connections	
4. Faulty ammeter or battery gauge	4. Best way to test is to replace gauge
5. Battery will not accept charge	5. Low electrolyte, failed battery
6. Faulty alternator or regulator	
7. Failed fuse (if so equipped)	7. Fuse located on starter terminal stud. Orange output wire from alternator connects to fuse.
8. Refer to "Section 4 Part C" for complete Charging System troubleshooting procedures.	

NOISY ALTERNATOR

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Worn, frayed, loose.
2. Loose drive pulley	
3. Worn or dirty bearings	
4. Faulty stator	
5. Faulty diode trio or stator	

INSTRUMENTATION MALFUNCTION

CAUSE	SPECIAL INFORMATION
1. Faulty wiring, loose or corroded terminals	
2. Bad key switch	2. Test, as outlined in "Section 4, Part D".
3. Faulty gauge	3. Test, as outlined in "Section 4, Part D".
4. Faulty sender	4. Test, as outlined in "Section 4, Part D".

RADIO NOISE

CAUSE	SPECIAL INFORMATION
1. A "popping" noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	1. Ignition System - wrong spark plugs, cracked distributor cap, cracked coil tower, leaking spark plug wires, moisture on ignition components.
2. A "hissing or crackling" noise when instruments are jarred with ignition on	2. Instrumentation - loose connections, or antennae wire routed too close to instruments.
3. Varying unexplained noises	3. Accessories - bilge pump, bilge blower, fish finder, depth locator, cabin heater motor, etc. Disconnect one at a time until noise disappears.

POOR FUEL ECONOMY

CAUSE	SPECIAL INFORMATION
1. Fuel leaks	
2. Operator habits	2. Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution
3. Engine laboring	3. Bent, damaged, wrong propeller. Water test boat for proper operating RPM at WOT.
4. Clogged flame arrestor	
5. Engine compartments sealed too tight	
6. Boat bottom	6. Dirty (marine growth), hook, rocker
7. Carburetor	7. Idle mixture settings, accelerator pump adjustment, linkage binding, choke adjustment, carburetor flooding over, main fuel jets
8. Improper fuel	
9. Crankcase ventilation system not working	
10. Engine needs tune-up	
11. Engine running too cold or too hot	
12. Plugged or restricted exhaust	
13. Engine	13. Low compression.

CARBURETOR MALFUNCTIONS

SYMPTOM	CAUSE
1. Flooding	1. A. Needle and seat B. Float adjustment C. Saturated float D. Gaskets leaking E. Cracked fuel bowl F. Fuel percolation G. Automatic choke
2. Rough idle	2. A. Idle RPM too low B. Idle mixture screws C. Idle passages dirty D. Throttle valves not closing E. Engine flooding F. Vacuum leak G. Throttle body heat passages plugged
3. Hesitation or acceleration flatness	3. A. Accelerator pump B. Leaking gaskets C. Automatic choke D. Power piston or power valve E. Throttle valves F. Throttle body heat passages plugged G. Main metering jets H. Float adjustment I. Secondary air valve wind-up
4. Engine surges	4. A. Main metering jets B. Leaking gaskets C. Float adjustment D. Saturated float E. Power piston or valve F. Throttle valves
5. Low top speed or lack of power	5. A. Power piston or valve B. Float adjustment C. Main metering jets D. Leaking gaskets
6. Poor cold engine operation	6. A. Idle RPM too low B. Idle mixture screws C. Throttle valves D. Automatic choke E. Engine flooding
7. Engine stalls	7. A. Idle RPM too low B. Idle mixture screws C. Engine flooding D. Automatic choke E. Dirt in carburetor F. Accelerator pump G. Leaking gaskets
8. Hard starting	8. Refer to "Engine Starts Hard"

ENGINE RUNS POORLY AT IDLE

CAUSE	SPECIAL INFORMATION
1. Clogged flame arrestor	
2. Improper idle fuel mixture adjustment	
3. Moisture on ignition components	3. Cap or spark plug wires arcing
4. Water in fuel	
5. Low grade or stale fuel	
6. Incorrect ignition timing	
7. Automatic choke	
8. Spark plugs	8. Fouled, burned, cracked porcelain
9. Incorrect point gap, burned or pitted points	
10. Spark plug wires	10. Insulation break down, wires broken
11. Defective coil or condenser	
12. Cracked or dirty distributor cap	
13. Incorrect float level	
14. Dirty carburetor	
15. Vacuum leak	15. Leak at manifold or carburetor base
16. Incorrect fuel pump pressure	16. Too low, can't supply the carburetor Too high, unseats the needle and seat
17. Low compression	17. Also check for blown head gasket
18. Loose or worn distributor	18. Timing and/or dwell changes
19. Water leaking into cylinders	19. Head gasket, exhaust manifold, cracked head or valve seat
20. Loose or broken engine mounts	

ENGINE ACCELERATION IS POOR

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance"	1. See "Index".
2. Idle mixture screws	
3. Air valve spring out of adjustment	3. Rochester 4 barrel carburetor only.
4. Incorrect ignition timing	
5. Incorrect distributor advance curve	5. Refer to Section 4, Part B.
6. Accelerator pump	6. Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off.
7. Cracked or dirty distributor cap or rotor	
8. Vacuum leak	8. Manifold or carburetor base.
9. Spark plugs	9. Fouled, burned; wrong heat range; cracked porcelain.
10. Incorrect point gap; dirty or burned points	
11. Float adjustment	
12. Dirty carburetor	
13. Low compression	

ENGINE RUNS POORLY AT HIGH RPM

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance"	1. See "Index".
2. Crankcase over-filled with oil	2. Check oil level with boat at rest in the water. Refer to Section 1, Part B.
3. Anti-siphon valve (if equipped)	3. Restricting fuel supply.
4. Plugged fuel tank vent	
5. Fuel supply	5. Refer to "Carburetor Malfunctions". (See "Index".)
6. Ignition timing	
7. Low grade of fuel or water in the fuel	
8. Spark plugs	8. Fouled, burned, cracked porcelain, incorrect heat range.
9. Spark plug wires	9. Poor insulation, broken wires.
10. Distributor cap or rotor	10. Dirty or cracked.
11. Coil	
12. Distributor	12. Points, condenser, worn cam, excessive play in shaft.
13. Engine overheating	13. Refer to "Engine Overheats". (See "Index".)
14. Low compression	14. Worn valves, rings, cylinders, etc.
15. Restricted exhaust	

TROUBLESHOOTING WITH VACUUM GAUGE

READING	CAUSE
1. Steady reading betweeen 15-21 inches at idle RPM	1. Normal.
2. Extremely low reading, but steady at idle RPM	2. Vacuum leak; incorrect timing; under powered boat; faulty boat bottom.
3. Fluctuates between high and low at idle RPM	3. Blown head gasket between 2 adjacent cylinders.
4. Fluctuates 4 or 5 inches very slowly at idle RPM	4. Carburetor needs adjustment; spark plug gap too narrow; valves are sticking.
5. Fluctuates rapidly at idle, steadies as RPM is increased	5. Valve guides are worn.
6. Continuously fluctuates between low and normal reading at regular intervals at idle RPM	6. Burned or leaking valve.

ENGINE NOISE

IMPORTANT INFORMATION

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed, are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine. Front to back; top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and, loose flywheel cover. In many cases, if this is found to be the problem, a complete engine tear down is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine or drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

VALVE COVER AREA

LOCATION	POSSIBLE CAUSES
1. Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders.	1. A. Rocker arm striking valve cover B. Rocker arm out of adjustment C. Worn rocker arm D. Bent push rod E. Collapsed lifter

CYLINDER AREA

LOCATION	POSSIBLE CAUSES
1. Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	1. A. Sticking valve B. Carbon build-up C. Connecting rod installed wrong D. Bent connecting rod E. Piston F. Piston rings G. Piston pin H. Cylinder worn

CAMSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Camshaft area, front of engine, timed to one-half engine speed	1. A. Camshaft timing sprocket B. Timing chain C. Fuel pump D. Valve lifter E. Cam bearings
2. Camshaft area, center of engine, timed to one-half engine speed	2. A. Fuel pump B. Valve lifter C. Cam bearings
3. Camshaft area, rear of engine, timed to one-half engine speed	3. A. Distributor gear B. Valve lifter C. Cam bearings
4. Camshaft area, throughout engine, timed to one-half engine speed	4. A. Loss of oil pressure B. Valve lifters C. Cam bearings

CRANKSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Crankshaft area, front of engine, timed to engine speed	1. A. Crankshaft timing sprocket B. Timing chain C. Main bearing D. Rod bearing
2. Crankshaft area, center of engine, timed to engine speed	2. A. Crankshaft striking pan or pan baffle B. Main bearing C. Rod bearing
3. Crankshaft area, rear of engine, timed to engine speed	3. A. Loose flywheel cover B. Loose coupler C. Loose flywheel D. Drive plate E. Main bearing F. Rod bearing
4. Crankshaft area, throughout engine, timed to engine speed	4. A. Loss of oil pressure B. Main bearings C. Rod bearings

MISCELLANEOUS

NOISE	POSSIBLE CAUSE
1. Engine spark knock	1. A. Advanced timing B. Low octane fuel C. Engine running hot D. Carbon deposits in engine
2. Popping through carburetor	2. A. Wrong ignition timing B. Carburetor set too lean C. Faulty accelerator pump D. Vacuum leak E. Valve adjustment F. Valve timing G. Burned or stuck valve
3. Hissing	3. A. Vacuum leak B. Fuel pump (hissing in sight tube) C. Leaking exhaust (manifolds or pipes) D. Loose cylinder heads E. Blown head gasket
4. Whistle	4. A. Vacuum leak B. Dry or tight bearing in an accessory
5. Sparks jumping	5. A. Leaking high tension lead B. Cracked coil tower C. Cracked distributor cap
6. Squeaks or squeals	6. A. Drive belt slipping B. Dry or tight bearing in an accessory C. Parts rubbing together
7. Rattling in exhaust pipe area	7. A. Exhaust shutters

OIL PRESSURE

IMPORTANT INFORMATION

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure reading.

CAUSE	SPECIAL INFORMATION
1. Measuring oil pressure	1. Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
2. Check engine oil level with boat at rest in the water	2. Oil level should be between the "ADD" and "FULL" marks.
3. Oil level in crankcase above "FULL" mark	3. May cause loss of engine RPM, oil pressure gauge flucuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM.
4. Oil level in crankcase below "ADD" mark	4. Low oil pressure; oil pressure gauge flucuation; internal engine noise and/or damage.
5. Change in oil pressure	5. This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal operating temperature, it is normal for oil pressure to drop off slightly.
6. Low engine oil pressure at idle	6. With modern engines and engine oils, low oil pressure readings at idle does not necessarily mean there is a problem. If valve lifters do not "clatter" (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thin out somewhat from heat.
7. Low engine oil pressure at idle after running at a high RPM	7. Refer to "No. 5 and 6" preceding.
8. Boats with dual engines	8. It is not uncommon to see different oil pressure readings between the two engines, as long as both engines are within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
9. Boats with dual stations	9. Refer to "No. 8" preceding.

LOW OIL PRESSURE

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure reading.

CAUSE	SPECIAL INFORMATION
1. Low oil level in crankcase	
2. Defective oil pressure gauge and/or sender	2. Verify reading with an automotive test gauge. Refer to "Section 4, Part D" for instrument testing.
3. Thin or diluted oil	3. Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation).
4. Oil pump	4. Relief valve stuck open; pick-up tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pick-up tube.
5. Oil leak, can be internal or external	5. Oil passage plugs leaking, cracked, or porous cylinder block.
6. Excessive bearing clearance	6. Cam bearings, main bearings, rod bearings.

HIGH OIL PRESSURE

CAUSE	SPECIAL INFORMATION
1. Oil too thick	1. Wrong viscosity, oil full of sludge or tar.
2. Defective oil pressure gauge and/or sender	2. Verify with an automotive test gauge. **IMPORTANT: Oil pressure slightly higher than normal does not always indicate a problem. Tolerance stack-up in the engine, oil viscosity, and weather conditions could cause high oil pressure.**
3. Clogged or restricted oil passage	
4. Oil pump relief valve stuck closed	

EXCESSIVE OIL CONSUMPTION

CAUSE	SPECIAL INFORMATION
1. Normal consumption	1. One quart of oil consumed in 5-15 hours of operation at WOT (especially in a new or rebuilt engine) is normal.
2. Oil leaks	2. Clean bilge; run engine with clean white paper on bilge floor; locate oil leak(s).
3. Oil too thin	3. Oil diluted or wrong viscosity.
4. Oil level too high	
5. Drain holes in cylinder head plugged	5. Oil will flood valve guides.
6. Defective valve seals	
7. Intake manifold gasket leaking	
8. Worn valve stems or valve guides	
9. Defective oil cooler (if so equipped)	9. Crack in cooler tubes.
10. Defective piston rings	10. Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap.
11. Defective cylinders	11. Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston.
12. Excessive bearing clearance	

WATER IN ENGINE

IMPORTANT INFORMATION

IMPORTANT: First, determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons".

The first step, after locating water, is to remove all water from the engine by removing all spark plugs and pump cylinders out by cranking engine over. Next change oil and filter. Now, start engine and see if problem can be duplicated. If problem can be duplicated, there more than likely is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If water is located in both cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete engine submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered through these areas.

WATER ON TOP OF PISTONS

CAUSE	SPECIAL INFORMATION
1. Operator shut engine off at high RPM	
2. Engine "diesels" or trys to run backwards	2. Engine out of tune; poor fuel; high idle RPM; timing set too high.
3. Rain water running into flame arrestor	3. Hatch cover.
4. Spark plug misfiring	4. Improper combustion causes moisture in the air to accumulate in the cylinder.
5. Backwash through the exhaust system	
6. Improper engine or exhaust hose installation	6. Refer to Section 6, Part B for exhaust specifications.
7. Cracked exhaust manifold	
8. Improper manifold to elbow gasket installation	
9. Loose cylinder head bolts	
10. Blown cylinder head gasket	10. Check for warped cylinder head or cylinder block.
11. Cracked valve seat	
12. Porous or cracked casting	12. Check cylinder heads, cylinder block, and intake manifold.

WATER IN CRANKCASE OIL

CAUSE	SYMPTOM
1. Water in boat bilge	1. Boat has been submerged or bilge water was high enough to run in through dipstick tube.
2. Water seeping past piston rings or valves	2. Refer to "Water in Engine (On Top of Pistons)".
3. Engine running cold	3. Defective thermostat, missing thermostat; prolonged idling in cold water.
4. Intake manifold leaking near a water passage	
5. Cracked or porous casting	5. Check cylinder head, cylinder block, and intake manifold.

ENGINE OVERHEATS (MECHANICAL)

CAUSE	SPECIAL INFORMATION
1. Engine RPM below specification at WOT (engine laboring)	1. Damaged or wrong propeller; growth on boat bottom; false bottom full of water.
2. Wrong ignition timing	2. Timing too far advanced.
3. Sticking distributor advance weights	
4. Spark plug wires crossed (wrong firing order)	
5. Lean fuel mixture	5. Refer to "Carburetor Malfunctions", in this section.
6. Wrong heat range spark plugs	
7. Exhaust restriction	
8. Valve timing off	8. Jumped timing chain or improperly installed.
9. Blown head gasket	9. A blown head gasket normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM. Refer to Section 6, Part A.
10. Insufficient lubrication to moving parts of engine	10. Defective oil pump, plugged oil passage, low oil level.

ENGINE OVERHEATS (COOLING SYSTEM)

CAUSE	SPECIAL INFORMATION
IMPORTANT: The first step is to verify if the engine is actually overheating or if the temperature gauge or sender is faulty.	**IMPORTANT: Best way to test gauge or sender is to replace them.**
1. Loose or broken drive belt	
2. Seawater inlet hose kinked or collapsed	
3. Seawater pick-up clogged	
4. Obstruction on boat bottom causing water turbulence	4. Obstruction will be in front of seawater pick-up, causing air bubbles to be forced into cooling system.
5. Defective thermostat	
6. Exhaust elbow water outlet holes plugged	
7. Insufficient seawater pump operation	7. Worn pump impeller.
8. Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	8. Refer to water flow diagram for engine type being serviced.
9. Engine circulating pump defective	
10. Also refer to "ENGINE OVERHEATS (MECHANICAL)"	10. See "Index".
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
11. Low coolant level	
12. Anti-freeze not mixed properly	12. Anti-freeze should be mixed 50/50 or maximum 60/40. 60% anti-freeze, 40% water.
13. Heat exchanger cores plugged	
14. Water hoses reversed at the water distribution block	14. Refer to water flow diagrams Section 6, Part A.
15. For further testing of the closed cooling system	15. Refer to Section 6, Part A.

INSUFFICIENT WATER FLOW FROM DRIVE UNIT SEAWATER PICKUP PUMP

CAUSE	SPECIAL INFORMATION
1. Seawater shut-off valve partially or fully closed (if equipped)	
2. Water pickups clogged with foreign material	
3. Kinked or broken bell housing-to-gimbal housing water tube hose	
4. Corroded thru gimbal housing water tube	
5. Water pickup inserts warped. (Engine will overheat while boat is underway only.)	5. Pickup inserts must not protrude above gear housing surface or inserts will create an irregular or turbulent water flow over the water pickup holes. Consequently, this may cause loss of cooling water and subsequent engine overheating. This condition also can be identified by cavitation burn (pitting, erosion) on the gear housing in the area aft of the water pickup inserts.
6. Damaged gear housing or accessories improperly installed on boat bottom or transom (speedometer pickup, depth sounder transducer, etc.). Substantial amount of barnacles or other marine growth on gear housing or boat bottom. (Engine will overheat while underway only.)	6. An object or an irregularity on boat or gear housing in area close to water pickups could create turbulence in water flow going to water pickups. This could aerate the water flow and cause engine to overheat.
7. Stern drive installed too high on transom or drive unit trimmed too far out allowing air to be drawn into pump. (Engine will overheat while underway only.)	7. Contact boat company if stern drive is installed too high. Instruct operator on proper trimming technique if unit is trimmed out too far.
8. Bell housing-to-drive shaft housing "O" ring missing or damaged	
9. Faulty seawater pickup pump	
10. Seawater pickup pump water tube corroded thru	
11. Drive shaft housing water pocket cover cracked	
12. Broken-off impeller blade or other obstruction in water passages (usually lodges in drive shaft housing water pocket cover or cross-drilled water passage).	12. To check cross-drilled water passage in drive shaft housing, remove welch plug and pipe plug located under decal on starboard side of housing. Drive unit must be shifted into reverse to remove pipe plug.
13. Water passage in drive shaft housing improperly drilled	

POWER STEERING

POOR, ERRATIC, OR NO ASSIST

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Broken or out of adjustment.
2. Low fluid level	
3. Air in system	3. Air leak in lines, pump, or air from installation. Refer to Section 7 for bleeding procedure.
4. Leaking hoses	4. Refer to Section 7 for bleeding procedure.
5. Steering cable and/or steering helm	5. Cable or helm partially froze from corrosion or rust; cable over lubricated; improper cable installation.
6. Binding in stern drive unit	6. Refer to appropriate "Stern Drive Service Manual".
7. Restriction in hydraulic hoses	7. Causes a loss of pressure.
8. Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
9. Mounting bracket adjusting screw loose or mounting tube is loose	
10. Faulty pump	10. Flow control valve may be sticking.
11. Worn piston ring or scored housing bore in cylinder	11. Causes loss of pressure.
12. Leaking valve body or loose fitting spool	

NOISY PUMP

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Check tension.
2. Low fluid level	
3. Air in fluid	3. Air leak in lines, pump, or air from installation. Refer to Section 7 for bleeding procedure.
4. Faulty pump	4. Use stethoscope to listen for noise in the pump.
5. Restricted fluid passages	5. Kinks or debris in hoses or debris in passages.
6. Stop nut adjusted improperly	6. Refer to appropriate "Stern Drive Service Manual".
7. Steering cables used do not meet BIA standards	7. Refer to appropriate "Stern Drive Service Manual".

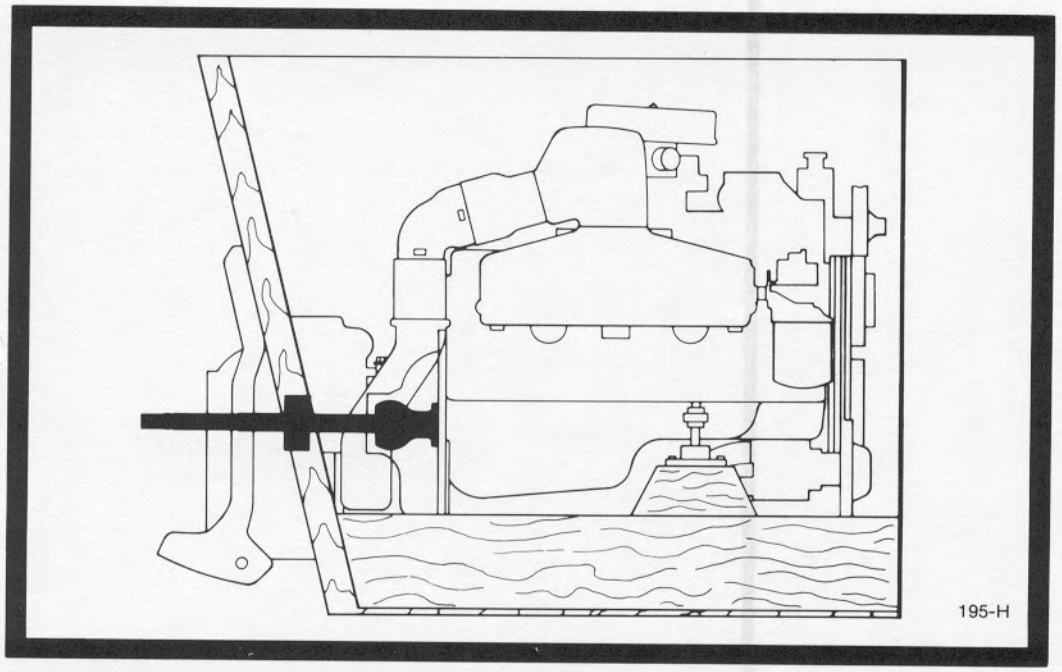
FLUID LEAKS

CAUSE	SPECIAL INFORMATION
1. Loose hose connections	1. Refer to Section 7 for bleeding procedure.
2. Damaged hose	
3. Oil leaking from top of pump	3. System overfilled; fluid contains water; fluid contains air.
4. Cylinder piston rod seal	
5. Faulty seals in valve	
6. Faulty seals or "O" rings in pump	
7. Cracked or porous metal parts	

REMOVAL and INSTALLATION

2

A



224 CID (3.7L)

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Torque Specifications	2A-1
Lubricants	2A-1
Tools	2A-1
Removal	2A-1
Installation/Alignment	2A-4
Installing Throttle Cables	2A-7

2

A

Torque Specifications

NOTE: Listed Below Are the Torque Specifications for Those Fasteners Which Have a Specific Torque Value. Tighten All Other Fasteners (Not Listed) Securely.

Description	Torque Value
Exhaust Pipe to Gimbal Housing Screws	20-25 lbs. ft. (27-34 N.m)
Rear Engine Mount Bolts/Nuts	35-40 lbs. ft. (47-54 N.m)
Power Trim Cylinders to Anchor Pin Nuts	Tighten until they bottom out.
Propeller Nut	55 lbs. ft. (75 N.m) MINIMUM
Shift Cable End Guide Attaching Nuts	Tighten each nut until it bottoms out against flat washer, then back-off 1/2 turn.
Fuel Line Inlet Fitting	10-18 lbs. ft. (14-24 N.m)
Steering Cable Coupler Nut	35 lbs. ft. (48 N.m)
Steering Cable Coupler Nut Locking Plate Screw (If Equipped with Optional Power Steering)	60-72 lbs. in. (6.8 - 8.1)
Steering System Pivot Bolts	25 lbs. ft. (34 N.m)
Stern Drive Unit to Bell Housing Attaching Nuts	50 lbs. ft. (68 N.m)
Transom Assembly Attaching Screws and Nuts	20-25 lbs. ft. (27-34 N.m)
Power Steering Hydraulic Hose Fittings — Large	20-25 lbs. ft. (27-34 N.m)
— Small	96-108 lbs. in. (10.8 - 12.2 N.m)

Lubricants

92-86154A1	Quicksilver 2-4-C Marine Lube
92-816391A4	Quicksilver Engine Coupler Spline Grease

Tools

91-805475A1	Engine Alignment Tool

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables at battery.
2. Disconnect battery cables from engine and starter.

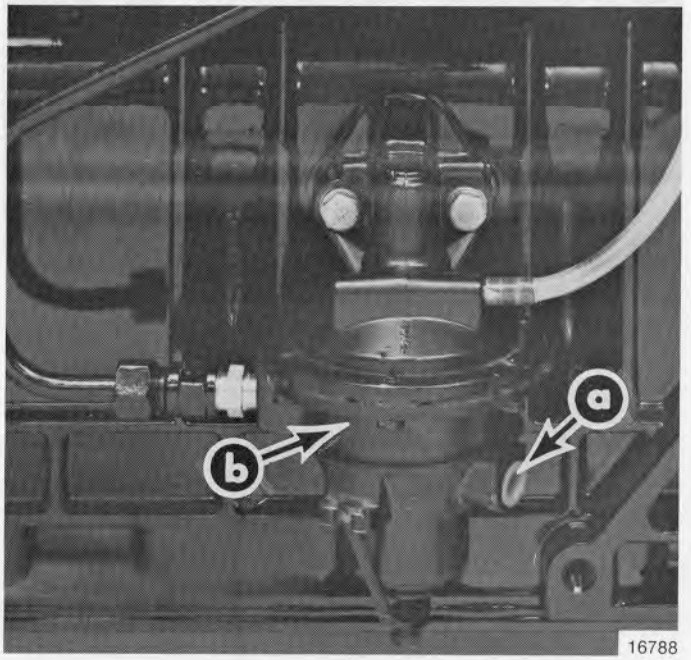
20101

a - Negative (-) Battery Cable
b - Rubber Boot (Slid Back from Terminal)
c - Positive (+) Battery Cable

⚠WARNING

Be careful when removing fuel line; gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow sources of spark or flame in the area when removing fuel line. Wipe up any spilled fuel immediately.

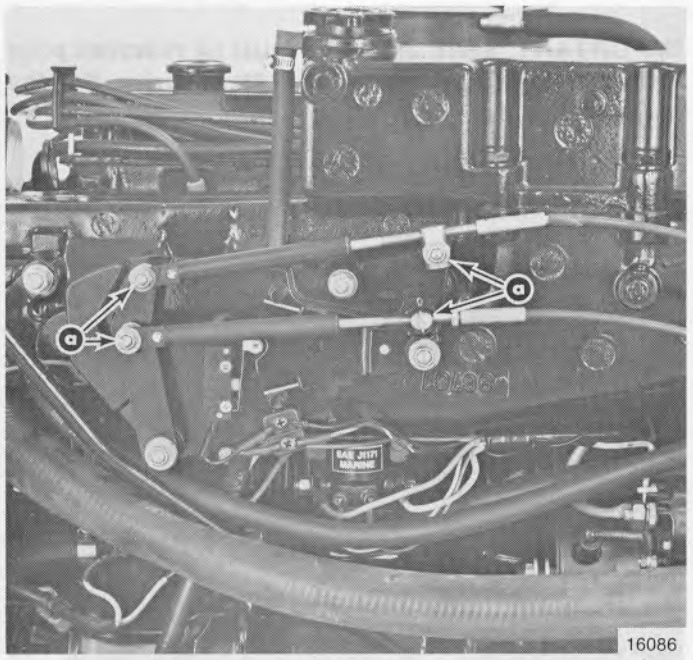
3. Disconnect and cap fuel line from fuel pump inlet.



16788

a - Remove Fuel Line From Here
b - Fuel Pump

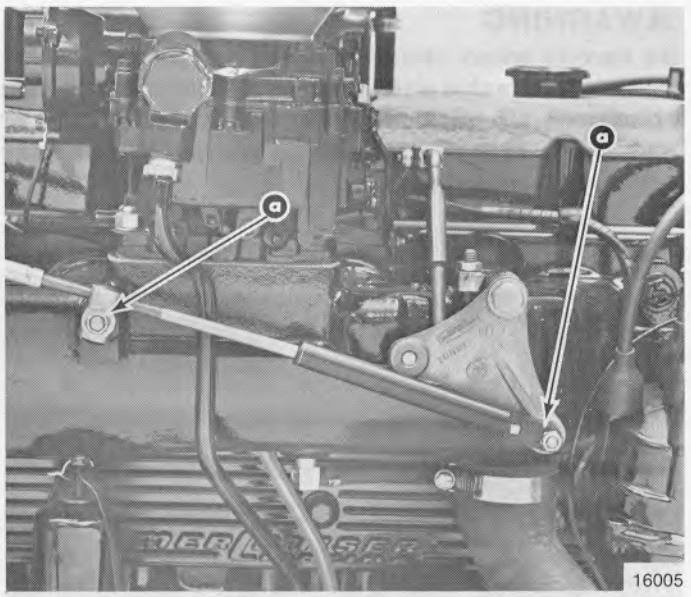
4. Disconnect shift cables.



16086

5. Disconnect throttle cables.

Throttle Cable - Two Barrel Carburetor

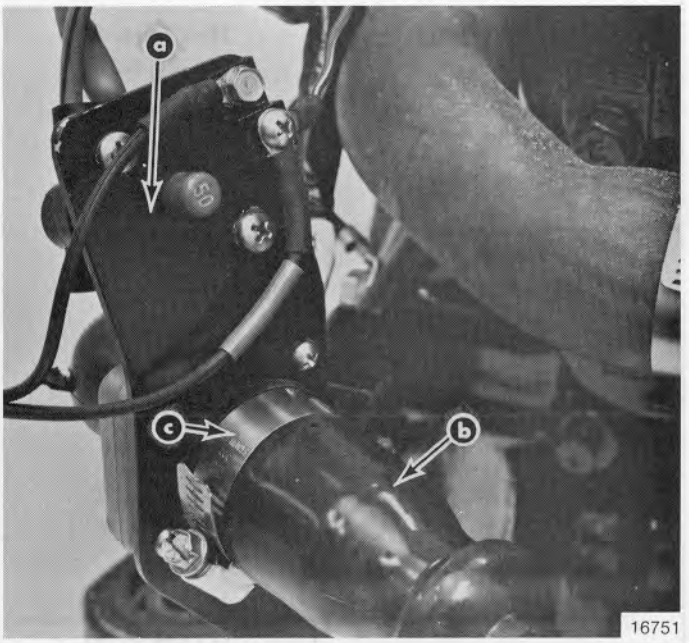


16005

Throttle Cable - Four Barrel Carburetor

16426

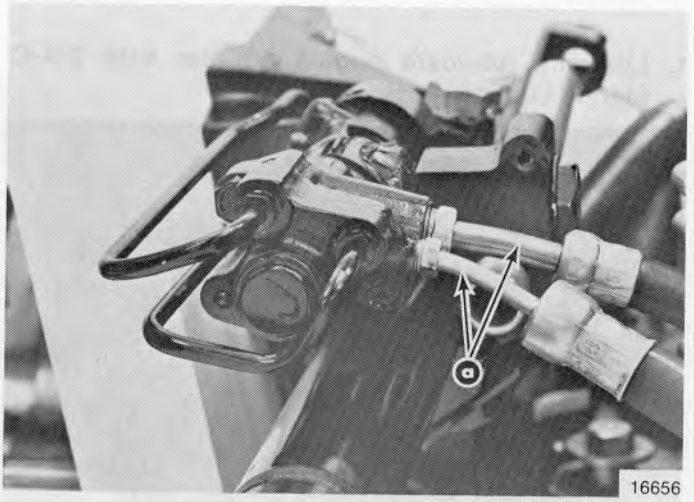
6. Loosen clamp and unplug harness.



16751

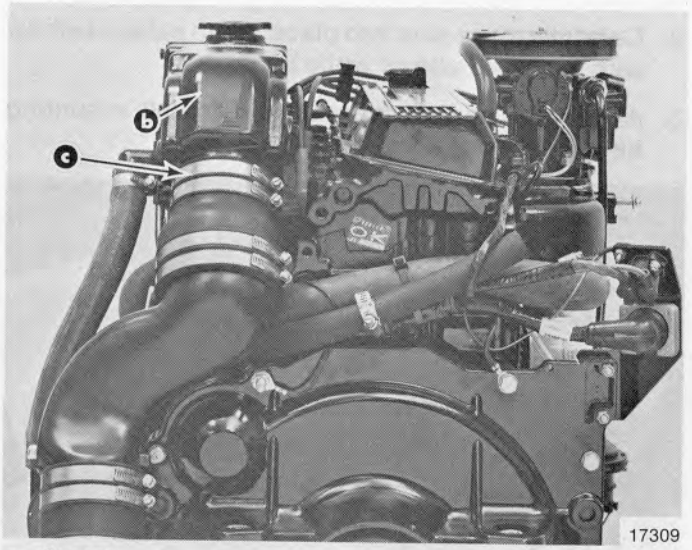
a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp

7. Disconnect and cap power steering hoses.



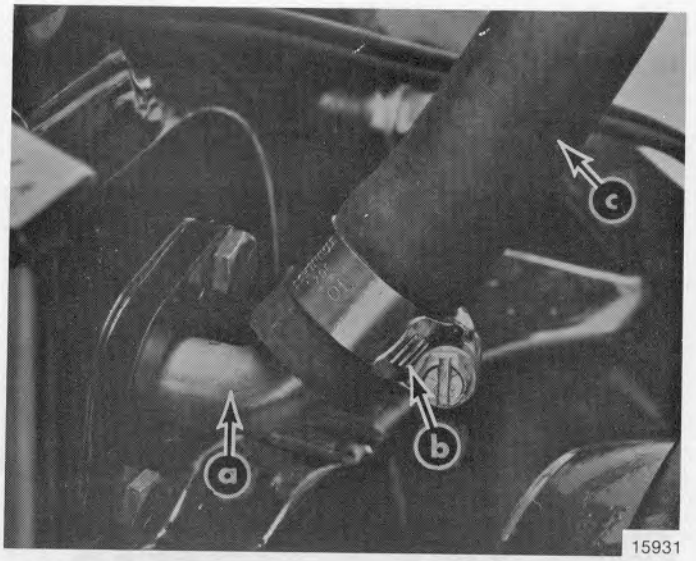
a - Power Steering Hoses

8. Loosen clamps and separate bellows from elbow.



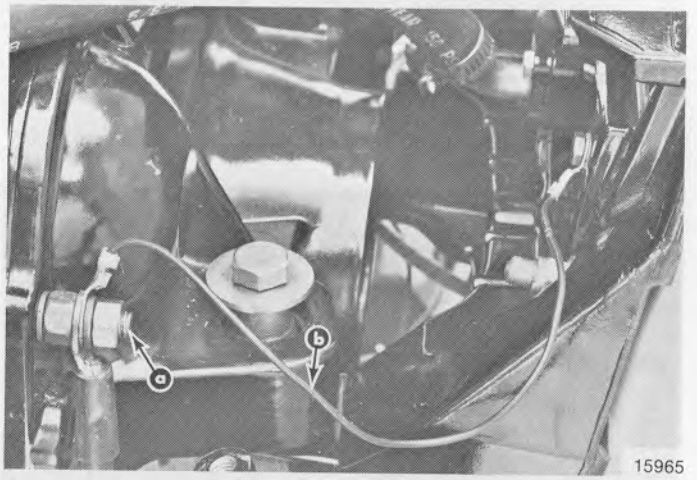
a - Clamps
b - Elbow

9. Loosen clamp and remove water inlet hose from water tube.



a - Water Tube
b - Hose Clamp
c - Water Hose

10. Disconnect ground wire from ground stud.

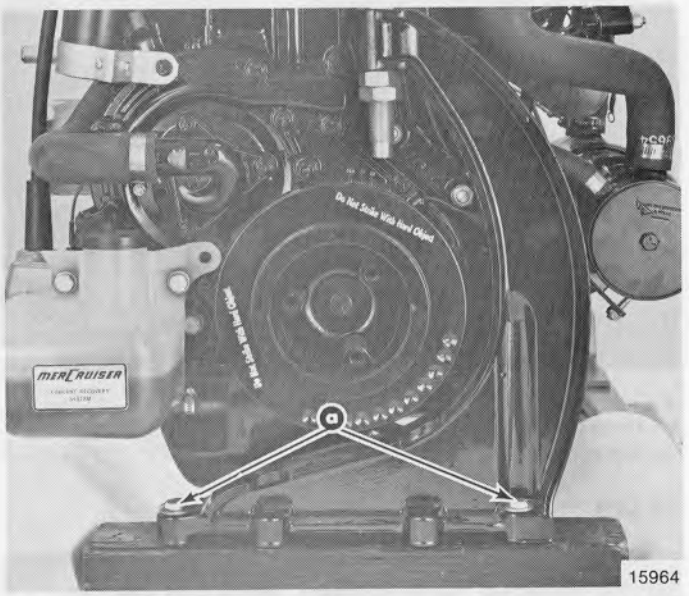


a - Flywheel Housing Attaching Screw and Grounding Stud
b - Ground Wire

11. Disconnect power trim position sender wires and any other wires connected to engine, including boat accessories.

12. Attach a suitable sling to lifting eyes.

13. Remove front mount retaining screws.



a - Retaining Screws

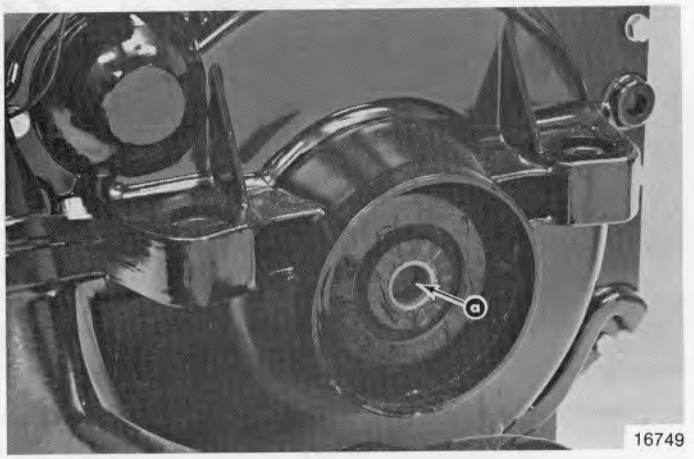
14. Remove rear engine mount bolts.

a - Rear Engine Mount Bolt

15. Carefully lift engine.

Installation/Alignment

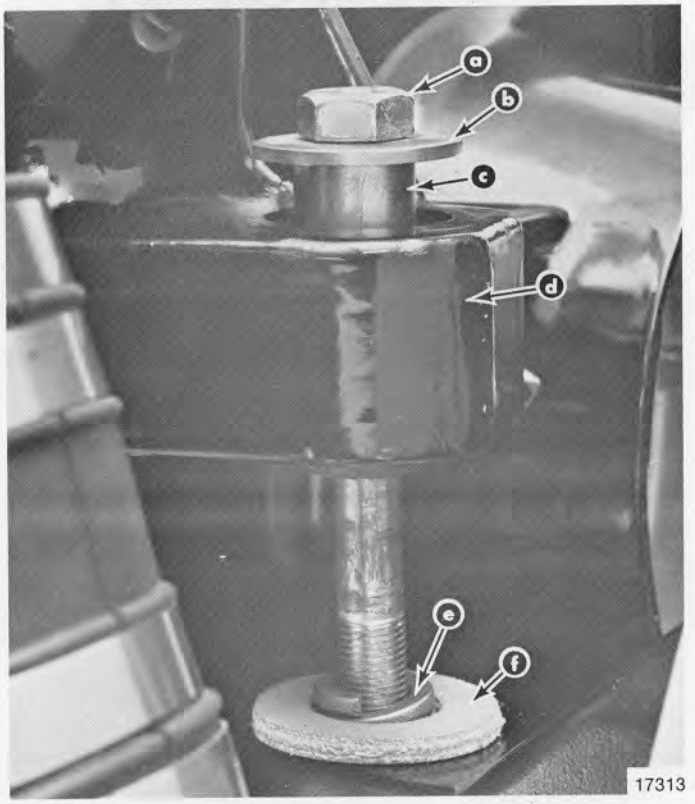
1. Liberally lubricate engine coupler with 2-4-C Marine Lubricant.



a - Engine Coupler

2. Carefully lift engine into place. Align exhaust elbow with exhaust bellows while installing.

3. Align rear engine mounts and install mounting hardware, as shown.

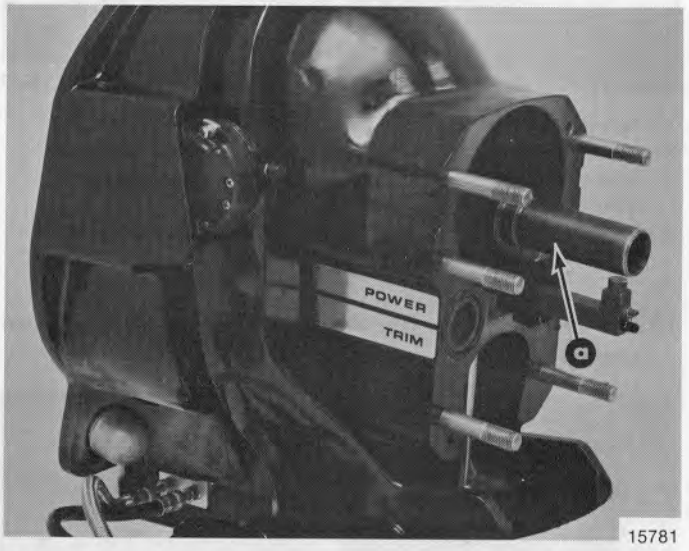


a - Rear Engine Mount Bolts
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer

4. Do not relieve hoist tension entirely.
5. Torque rear mount bolts to specifications.
6. Install alignment tool thru gimbal housing and into engine coupler.

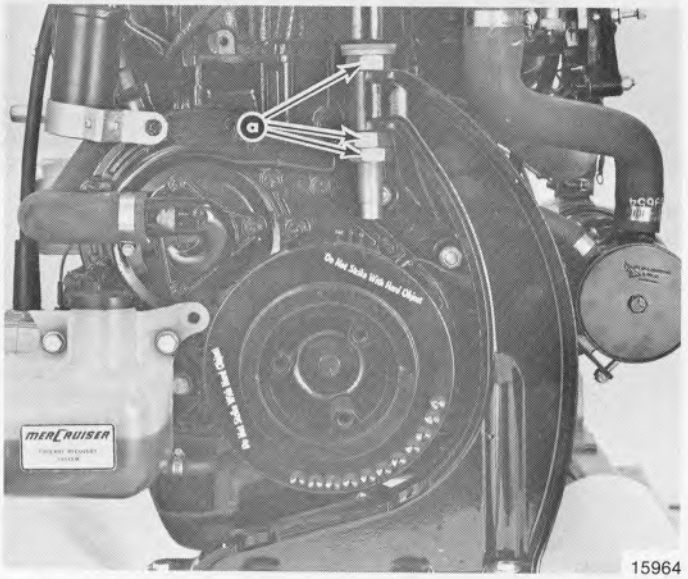
a - Insert This End of Alignment Tool thru Gimbal Housing Assembly

Alignment Tool 91-805475A1



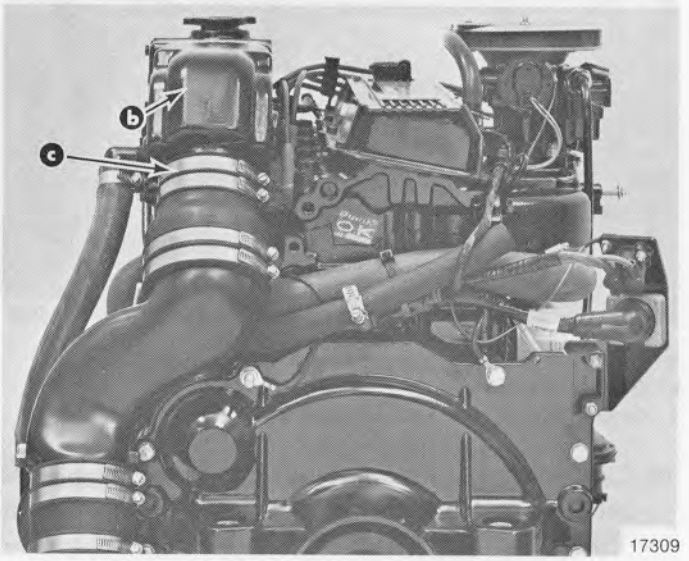
a - Alignment Tool

7. Raise or lower front of engine with hoist as required to allow alignment tool to slide freely all the way into engine coupler.
8. Tighten front mount locknut, jam nut, and adjusting nut. Reattach front mount to stringers.



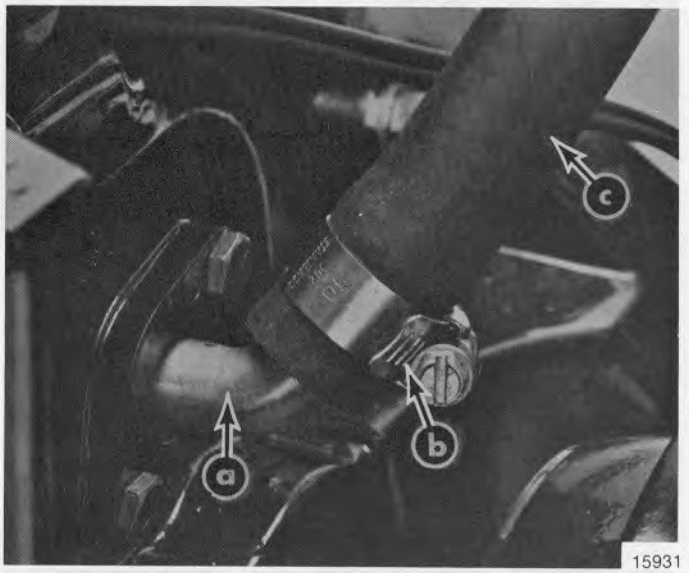
a - Tighten

9. Connect bellows to manifold and tighten clamps securely.



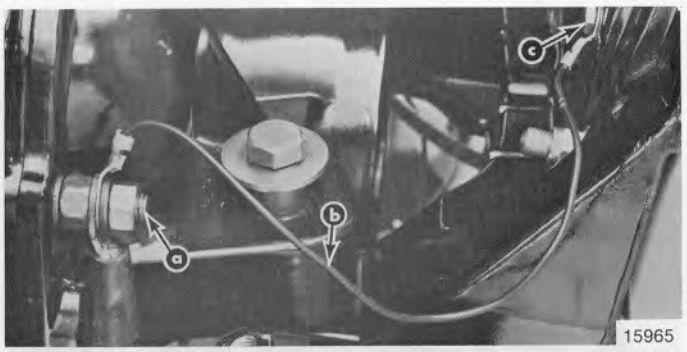
a - Clamps - Bellows
b - Manifold

10. Connect water inlet hose and tighten clamp securely.



a - Water Tube
b - Hose Clamp
c - Water Hose

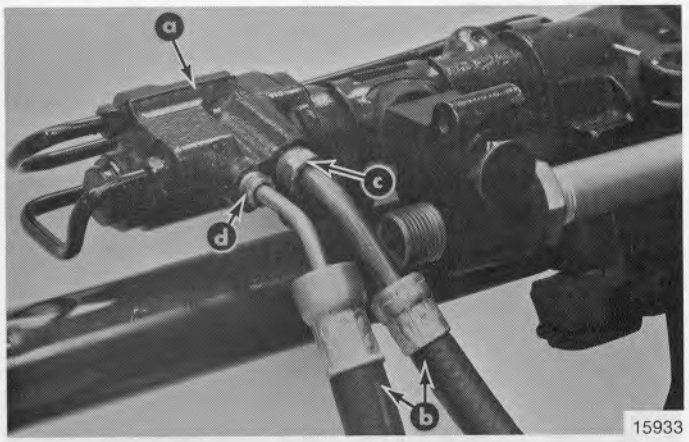
11. Attach ground wire to inner transom plate.



15965

a - Flywheel Housing Attaching Screw and Grounding Stud
b - Ground Wire
c - Inner Transom Plate Grounding Screw

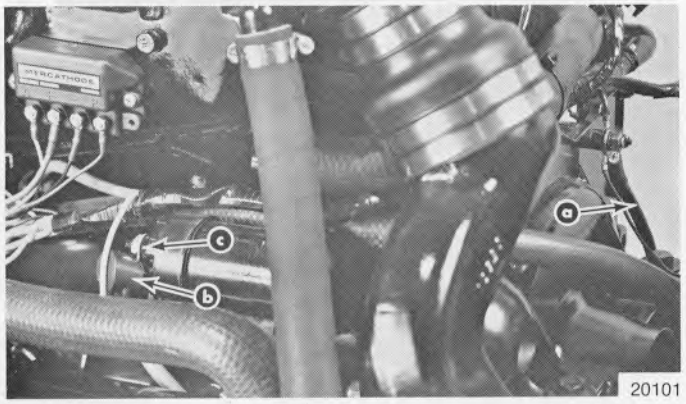
12. Connect power steering hoses. Tighten to specifications. To bleed power steering system, refer to "Power Package Installation Manual".



15933

a - Power Steering Control Valve
b - Hydraulic Hoses
c - Torque Large Fitting to 20-25 Lbs. Ft. (27-34 N.m). DO NOT OVER-TIGHTEN.
d - Torque Small Fitting to 96-108 Lbs. In. (10.8-12.2 N.m). DO NOT OVER-TIGHTEN.

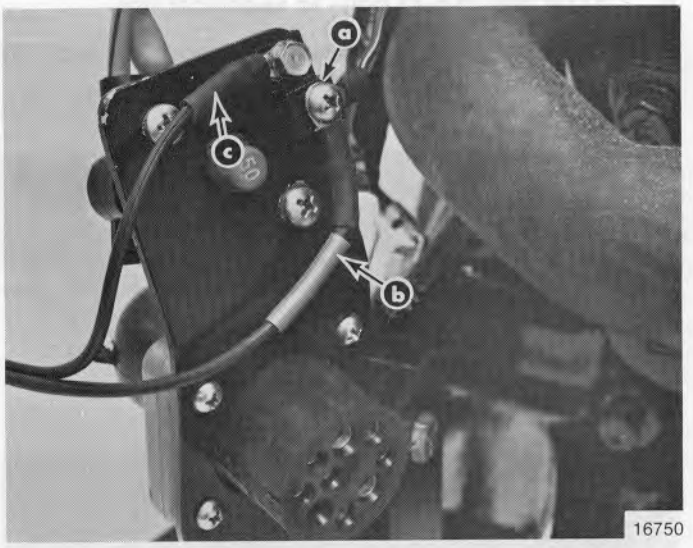
13. Connect battery cables to engine and starter, tighten securely.



20101

a - Negative (-) Battery Cable
b - Rubber Boot (Slid Back from Terminal)
c - Positive (+) Battery Cable

14. Connect trim limit switch leads as shown.



16750

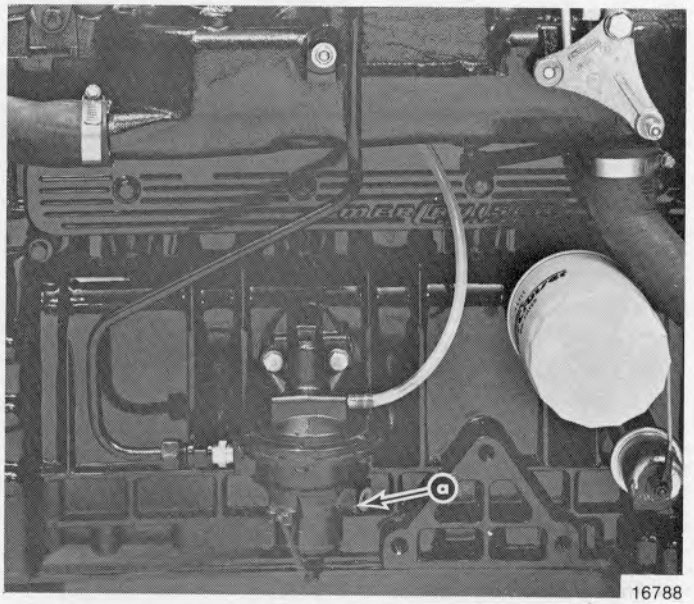
a - Terminal Block
b - Connect Trim Position Sender Lead with Brown or Purple Sleeve to Terminal Which Brown/White Lead Is Already Attached
c - Connect Trim Position Sender Lead without Sleeve to Terminal Block Mounting Screw

15. Connect wiring harness as shown and tighten clamp securely.

16751

a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp

16. Connect fuel line to fuel pump inlet and torque to specifications, 10-18 lbs. ft. (14-24 N.m).

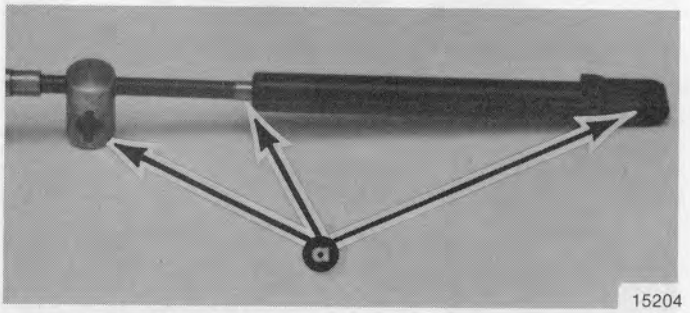


a - Fuel Pump Inlet

17. Connect any wiring previously removed.

Installing Throttle Cables

1. Lubricate cable ends (shift and throttle) with 2-4-C Marine Lubricant, at locations shown.



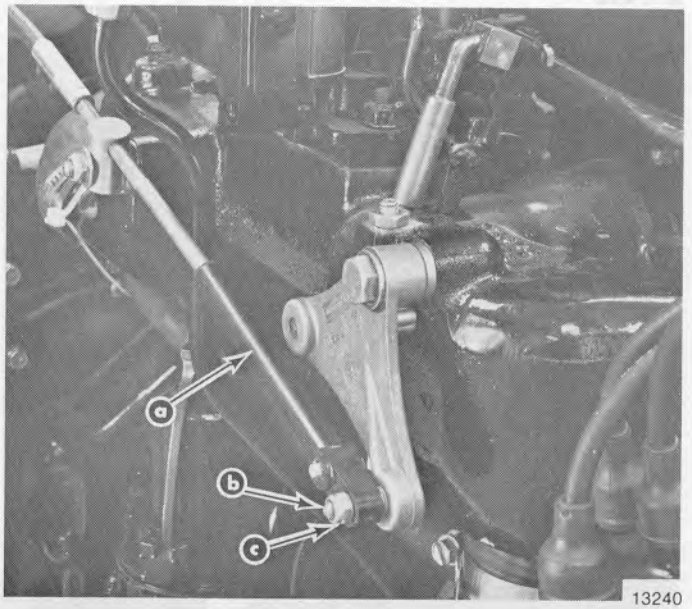
a - Lubricate with 2-4-C Marine Lubricant

⚠CAUTION

Throttle cable brass barrel must be adjusted properly. Over-adjusting barrel in the other direction will not allow throttle lever to return to idle position. Over-adjusting barrel in the other direction will exert excessive pressure on throttle lever which could cause damage to carburetor.

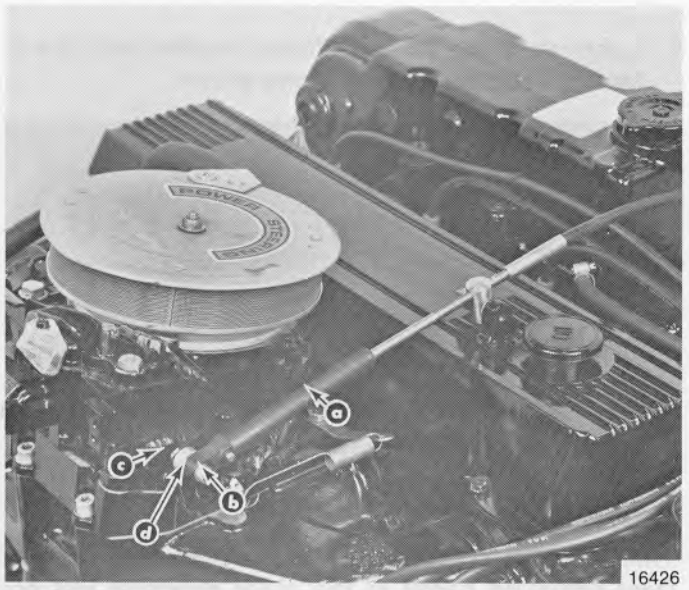
2. Place remote control handle in neutral.
3. Place cable end guide, flat washer and elastic stop nut onto throttle lever stud. Do not tighten at this time.

Two Barrel Carburetor



a - Cable End Guide
b - Throttle Lever Stud
c - Washer and Elastic Stop Nut

Four Barrel Carburetor

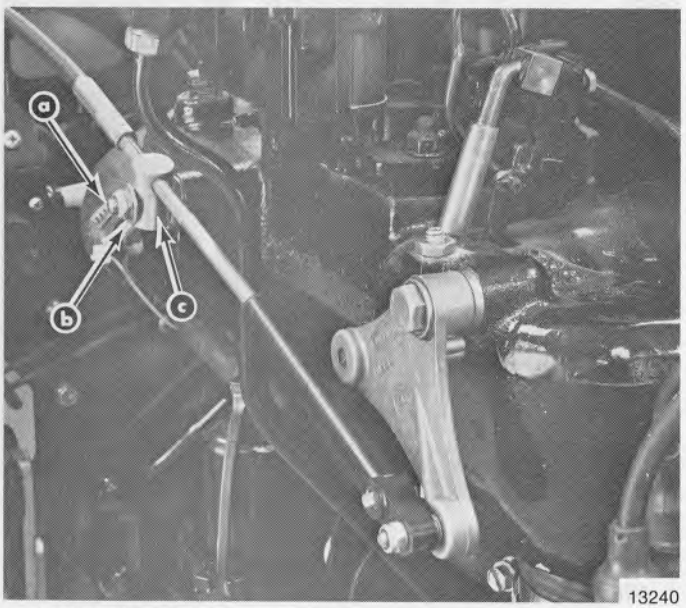


a - Cable End Guide
b - Throttle Lever Stud
c - Spacer
d - Elastic Stop Nut

4. Grasp cable behind brass barrel and push lightly toward throttle lever, then adjust brass barrel to align hole with throttle cable anchor stud (and spacer), and slide barrel onto stud. Secure barrel with flat washer and elastic stop nut.

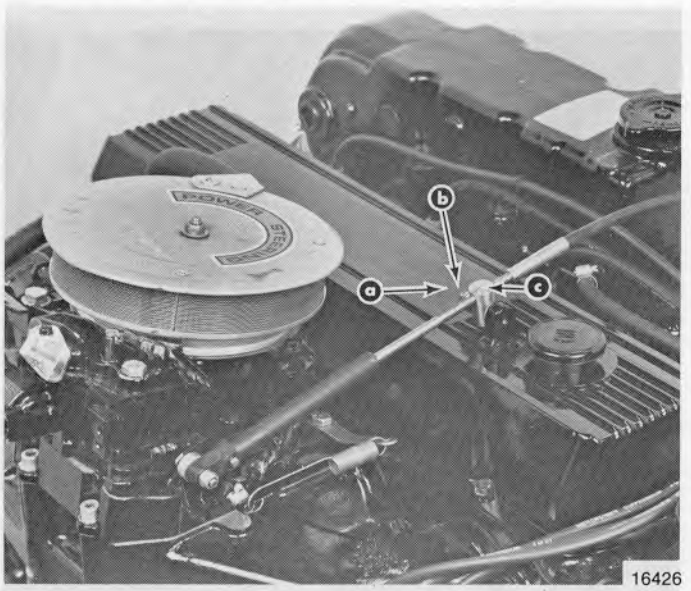
IMPORTANT: Brass barrel must position throttle cable so that cable is routed above the anchor stud, as shown.

Two Barrel Carburetor



a - Anchor Stud (with Spacer on Shank)
b - Flat Washer and Elastic Stop Nut
c - Throttle Cable Brass Barrel

Four Barrel Carburetor

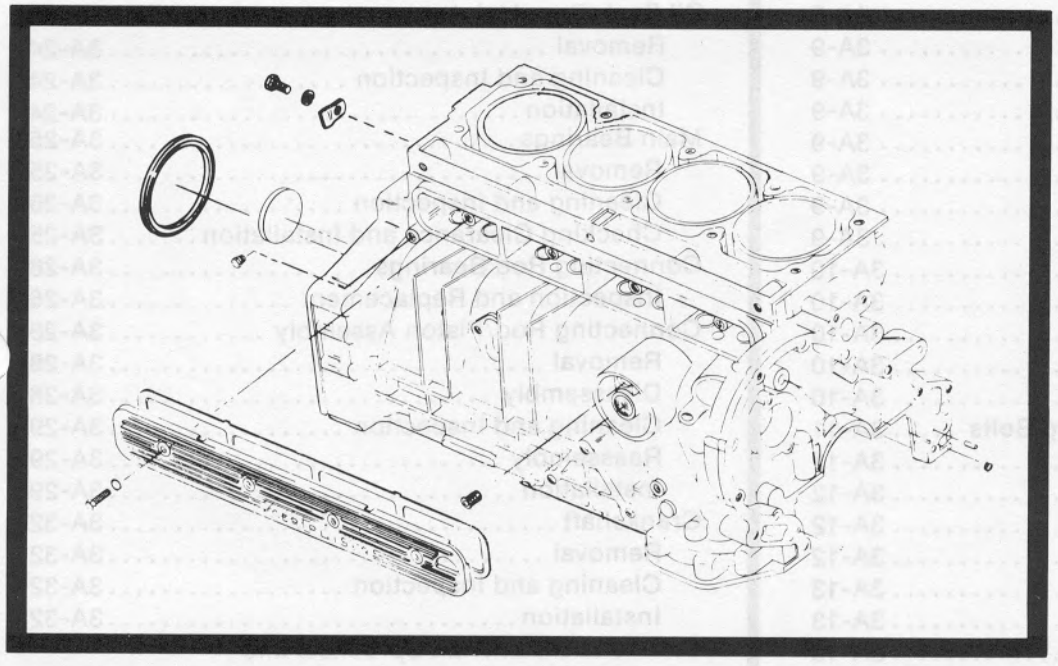


a - Anchor Stud (with Spacer on Shank)
b - Flat Washer and Elastic Stop Nut
c - Throttle Cable Brass Barrel

5. Check that throttle valves are fully open when remote control is in full forward position. If not, check brass barrel adjustment or remote control for sufficient travel. Return control to neutral gear, idle position and check that idle stop screw is against stop.
6. Tighten brass barrel attaching nut until it bottoms.
7. Tighten cable end guide attaching nut securely, then back off 1/2 turn.
8. For installation of drive unit and shift linkage, refer to appropriate "Stern Drive Service Manual".

ENGINE MECHANICAL

3
A



4 CYL. 224 CID (3.7 L)

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Torque Specifications	3A-1
Lubricants/Sealants	3A-1
Special Tools	3A-2
Engine Specifications	3A-3
General	3A-6
Engine Identification	3A-6
Serial No. Location	3A-6
Engine Rotation	3A-6
Crankshaft	3A-6
Piston and Connecting Rods	3A-6
Camshaft and Drive	3A-6
Cylinder Head	3A-6
Valve Train	3A-6
Lubrication System	3A-6
Oil Flow	3A-7
Front Mount	3A-8
Rear Mounts/Flywheel Housing	3A-8
Rocker Arm Cover	3A-9
Removal	3A-9
Cleaning and Inspection	3A-9
Installation	3A-9
Intake Manifold	3A-9
Removal	3A-9
Cleaning and Inspection	3A-9
Installation	3A-10
Rocker Arm/Push Rod	3A-10
Removal	3A-10
Cleaning and Inspection	3A-10
Installation	3A-10
Torquing Rocker Arm Attaching Bolts	3A-11
Checking Valve Clearance	3A-11
Hydraulic Valve Lifters	3A-12
Locating Noisy Lifters	3A-12
Removal	3A-12
Disassembly	3A-13
Cleaning and Inspection	3A-13
Reassembly	3A-13
Installation	3A-14
Valve Stem Oil Seal/Valve Spring	3A-14
Removal	3A-14
Installation	3A-14
Cylinder Head and Valves	3A-14
Removal	3A-14
Disassembly	3A-15
Cleaning and Inspection	3A-15
Valve Spring Inspection	3A-16
Valve Guide Bore Repair	3A-16
Valve Seat Repair	3A-17
Valve Repair	3A-17
Reassembly	3A-17
Installation	3A-18
Oil Pan	3A-19
Removal	3A-19
Cleaning and Inspection	3A-19
Installation	3A-19
Oil Pump	3A-19
Removal	3A-19
Disassembly	3A-20
Cleaning and Inspection	3A-20
Reassembly	3A-21
Installation	3A-21
Crankcase Front Cover/Oil Seal	3A-22
Removal - Front Cover Assembly	3A-22
Cleaning and Inspection	3A-22
Removal - Seals	3A-22
Installation	3A-22
Flywheel/Coupler	3A-24
Removal	3A-24
Inspection	3A-24
Installation	3A-24
Oil Seal (Rear Main)	3A-24
Removal	3A-24
Cleaning and Inspection	3A-24
Installation	3A-24
Main Bearings	3A-25
Removal	3A-25
Cleaning and Inspection	3A-25
Checking Clearance and Installation	3A-25
Connecting Rod Bearings	3A-26
Inspection and Replacement	3A-26
Connecting Rod/Piston Assembly	3A-28
Removal	3A-28
Disassembly	3A-28
Cleaning and Inspection	3A-29
Reassembly	3A-29
Installation	3A-29
Crankshaft	3A-32
Removal	3A-32
Cleaning and Inspection	3A-32
Installation	3A-32
Crankshaft/Camshaft Sprockets and Timing Chain	3A-34
Checking Timing Chain Deflection	3A-34
Removal	3A-34
Cleaning and Inspection	3A-34
Installation	3A-34
Camshaft	3A-35
Removal	3A-35
Inspection	3A-35
Installation	3A-35
Cylinder Block	3A-36
Cleaning and Inspection	3A-36
Repairs	3A-36
Cylinder Conditioning	3A-36
Cylinder Boring	3A-36
Cylinder Honing	3A-36
Piston Selection	3A-37

Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N·m
Alternator Rotor		75	102
Camshaft Impeller Stud (Note 1)		15	20
Camshaft Thrust Plate	115		13
Camshaft Sprocket Screws	150		17
Carburetor Mounting (2 Barrel)		20	27
Carburetor Mounting (4 Barrel)			
Chain Tightener Bolt			
Connecting Rod Cap		40	54
Engine Coupler		30	41
Flywheel / Crankshaft		75	102
Cylinder Head Bolts (Note 2)		130	176
Flywheel Housing to Block		30	41
Front Mount to Block		50	68
Impeller Cover		15	20
Impeller Screw 5/16-18			
Impeller (Note 3)			
Main Bearing Cap		55	75
Manifold To Head (Exhaust)		25	34
Manifold To Head (Intake)			
Oil Pan	130		15
Oil Pan Drain Plug		20	27
Oil Pump Cover	120		14
Oil Pump To Block		25	34
Oil Pump Pick Up		20	27
Oil Tube To Block		25	34
Rocker Arm Cover	90		10
Rocker Arm Bolt (Note 2)		20	27
Side Cover		15	20
Spark Plug (14 mm)			
Starter Motor		60	81
Stator To Front Cover	45		5
Timing Chain Cover		15	20
Water Pump Cover			

Notes: 1 Left Hand (LH) Thread. Use Loctite 35
2 Torque With Valves Closed, Retorque After First Start Up.
3 Left Hand (LH) Thread

LUBRICANTS/SEALANTS	
92-823089-1	Quicksilver Loctite
92-34227-1	Quicksilver Perfect Seal
92-825265A1	Quicksilver Needle Bearing Assembly Lubricant
92-91601-1	Quicksilver RTV Sealer
1052914	General Motors RTV Sealer
92-825407A2	Quicksilver 2-4-C Marine Lubricant

MERCURY MARINE SPECIAL TOOLS	
91-24697	Piston Ring Expander
91-35547	Engine Coupler Wrench
91-14822	Oil Pump Alignment Tool

KENT-MOORE SPECIAL TOOLS	
Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone 313-774-9500	
J5892	Valve Spring Compressing
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J8089	Carbon Remover Brush
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Guide Tool
J8087	Cylinder Bore Checker
J26817	Seal Installer
J6978-E	Alternator Rotor Remover
J21058-20	Alternator Rotor Installer

OWATONNA SPECIAL TOOLS	
Can be ordered from: Owatonna Tools, Inc. 2013 Fourth St., N.W. Industrial Part Warehouse Owatonna, MN 55060 Phone 507-455-2626	
T711P-6513A	Valve Lifter Collapsing Tool
T52L-6085AEE	Valve Guide Reamer Kit
T65L-6250-A	Bearing Installation Kit

ENGINE SPECIFICATIONS

UNIT OF MEASUREMENT
in. (mm)

MODEL	ALL MODELS
CU. IN. DISPLACEMENT	224 (3.7 litres)

CYLINDER BORE:

Diameter			4.3602-4.3609 (110.749-110.767)
Out of Round		Production	.0005 (.0127) Max.
		Service	.0015 (.0381) Max.
Taper	Production	Thrust Side	.0005 (.0127) Max.
		Relief Side	.0005 (.0127) Max.
	Service		.003 (.076) Max.

CYLINDER BLOCK:

Deck Height (Note 1)	Production	10.255-10.265 (260.477-260.731)
	Service	10.240 (260.096) Min.
Main Bearing Bore Diameter	Production	2.9417-2.9429 (74.7191-74.7497)
	Service	2.9435 (74.7649) Max.
Hydraulic Lifter Bore Diameter	Production	.875-.876 (22.225-22.250)
	Service	.878 (22.301) Max.
Camshaft Bore Diameter		2.1258-2.1278 (53.995-54.046)

NOTE 1: Measured from center of main bearing bore to top of cylinder block.

PISTON: CLEARANCE

Production	See Page 37
Service	See Page 37

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	.0025-.004 (.07-.1)
		2nd	.0025-.004 (.07-.1)
	Service	Top	.0025-.004 (.07-.1)
		2nd	.0025-.004 (.07-.1)
Gap	Production	Top	.010-.020 (.25-.5)
		2nd	.010-.020 (.25-.5)
	Service	Top	.010-.020 (.25-.5)
		2nd	.010-.020 (.25-.5)

PISTON RING: OIL

Groove Clearance	Production	.0011-.0065 (.03-.15)
	Service	.0011-.0065 (.03-.15)
Gap	Production	.010-.025 (.25-.6)
	Service	.010-.025 (.25-.6)

PISTON PIN:

Diameter		1.0399-1.0402 (26.413-26.421)
Clearance	Production	.0004-.0006 (.0102-.0152)
	Service	.0004-.0006 (.0102-.0152)
Fit in Rod		.0006-.0016 (.0152-.0406) Interference

MODEL	ALL MODELS

CRANKSHAFT:

Diameter			2.7472-2.7482 (69.779-69.804)
Main Journal	Taper	Production	.0002 (.0051) Max.
		Service	.0005 (.0127) Max.
	Out of Round	Production	.0002 (.0051) Max.
		Service	.0005 (.0127) Max.
Main Brg. Clearance	Production		.0009-.0035 (.0229-.0889)
	Service		.001-.0035 (.0254-.0889)
Rear Seal Area Diameter	Production		3.748-3.752 (95.1992-95.3008)
	Service		3.745 (95.123) Min.
Timing Sprocket (Note 1)	Production		1.380-1.381 (35.052-35.077)
	Service		1.379 (35.026) Min.
Balance of Crankshaft (Note 2)	Production		.50 oz. in.
Crankshaft End Play			.006-.010 (.15-.25)
Crankpin	Diameter		2.4979-2.4989 (63.447-63.472)
	Taper	Production	.0002 (.051) Max.
		Service	.0005 (.0127) Max.
	Out of Round	Production	.0002 (.051) Max.
		Service	.0005 (.0127) Max.
Rod Brg. Clearance	Production		.0009-.0031 (.0228-.0787)
	Service		.001-.003 (.03-.07)
Rod Side Clearance			.005-.012 (.15-.3)

NOTE 1: Because crankshaft has taper, measurement must be taken at rear half of sprocket area on crankshaft.
NOTE 2: Balanced without connecting rods.
NOTE 3: See page 39 for connecting rod measurements and clearances.

ALTERNATOR ROTOR:

Front Oil Seal Diameter	Production	1.873-1.877 (47.5742-47.6758)
	Service	1.871 (47.5234) Min.

CRANKSHAFT TIMING SPROCKET:

Inside Diameter	Production	1.381-1.382 (35.0774-35.1028)

CAMSHAFT:

End Play		.002-.005 (.06-.1)
Lobe Lift (Max.)	Intake	.287 (7.2898)
	Exhaust	.290 (7.3660)
Lobe Wear Limit		.009 (.2286) Max.
Journal Diameter		2.1238-2.1248 (53.9445-53.9699)
Clearance		.001-.0026 (.0254-.0660)
Camshaft Runout		.001 (.0254) Max.
Timing Chain Deflection		1 (25)

CYLINDER HEAD:

Gasket Surface Flatness	.005 (.1) Max.

MODEL	ALL MODELS

VALVE SYSTEM:

Lifter			Hydraulic
Rocker Arm Ratio			1.73:1
Collapsed Tappet Gap			.110-.210 (2.794-5.334)
Face Angle	Intake		44°
	Exhaust		44°
Seat Angle	Intake		45°
	Exhaust		45°
Seat Runout (Int. & Exh.)			.002 (.0508) Max.
Seat Width	Intake		.060-.080 (1.524-2.032)
	Exhaust		.060-.080 (1.524-2.032)
Stem Clearance	Production	Int.	.001-.0027 (.0254-.0686)
		Exh.	.001-.0027 (.0254-.0686)
	Service	Int.	.0037 (.0940) Max.
		Exh.	.0052 (.1321) Max.
Springs (Note 1)	Free Length		2.18 [2-3/16 (55)]
	Pressure Lbs. Ft.	Closed	90-100 at 1.86 [1-55/64] [122-136 N.m at (47)]
		Open	255-275 at 1.36 [1-23/64] [346-372 N.m at (35)]
	Installed Height ± 1/32" (.8mm)	Intake	1.86 [1-55/64 (47)]
		Exhaust	1.86 [1-55/64 (47)]
	Damper		External

NOTE 1: Test Springs with Damper Installed

General

Some repairs, that are listed in this section, must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

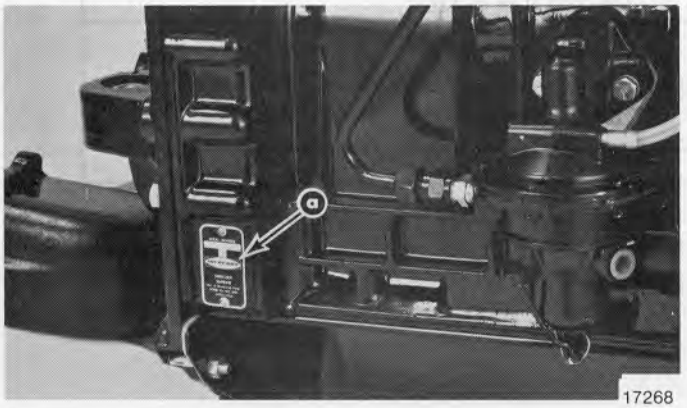
Lubricate all moving parts (during reassembly) with engine oil. Apply Perfect Seal on threads of and under head of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

ENGINE IDENTIFICATION

Engine determination is governed by carburetion.

The 165/170/3.7L engine has the 2 bbl. carburetor and the 180/190/3.7LX the 4 bbl. carburetor.

ENGINE SERIAL NO. LOCATION



a - Engine Serial Number Plate - Typical

ENGINE ROTATION

Engine rotation is determined by observing flywheel rotation from the stern drive end looking forward. Propeller rotation is not necessarily the same as engine, always be certain to check engine rotation when ordering parts.

CRANKSHAFT

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the number three bearings.

PISTON and CONNECTING RODS

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in the thrust-pressure against the cylinder walls as the piston travels its path.

Pins have a floating fit in the piston and a press fit in the connecting rod. Connecting rods are of forged steel and use insert type lower bearings.

CAMSHAFT and DRIVE

The camshaft is supported in the block by five bearing surfaces, and is driven half speed to the crankshaft by a timing chain and sprocket. Taper on the lobes and a spherical base on the hydraulic lifter cause lifter rotation and reduced wear. A helical gear on the camshaft drives the distributor and oil pump while an eccentric cam lobe on the camshaft accuates the fuel pump.

CYLINDER HEAD

The cylinder head is of cast iron and has individual intake and exhaust ports for each cylinder.

VALVE TRAIN

The valves and valve springs are a heavy duty design to withstand high engine speeds. Valve tips are hardened to extend valve life. Hydraulic lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the pushrods which activate the rocker arm and the valves. The hydraulic lifters also serve to remove any clearance or lash from the valve train and keep all parts in constant contact with one another. The lifters also meter oil to the valve train bearing surfaces.

LUBRICATION SYSTEM

The engine lubrication system is the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearing area and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other parts are lubricated by gravity flow or splash.

A positive displacement gear type oil pump is mounted on the block and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the oil pan is drawn into the oil pump through a pick-up screen and pipe assembly.

If the screen should become clogged, a relief valve in the pump will open and allow oil to be drawn into the system.

The pump forces the oil thru the lubrication system and a full flow oil filter. A spring loaded relief valve in the pump limits the maximum pump output pressure.

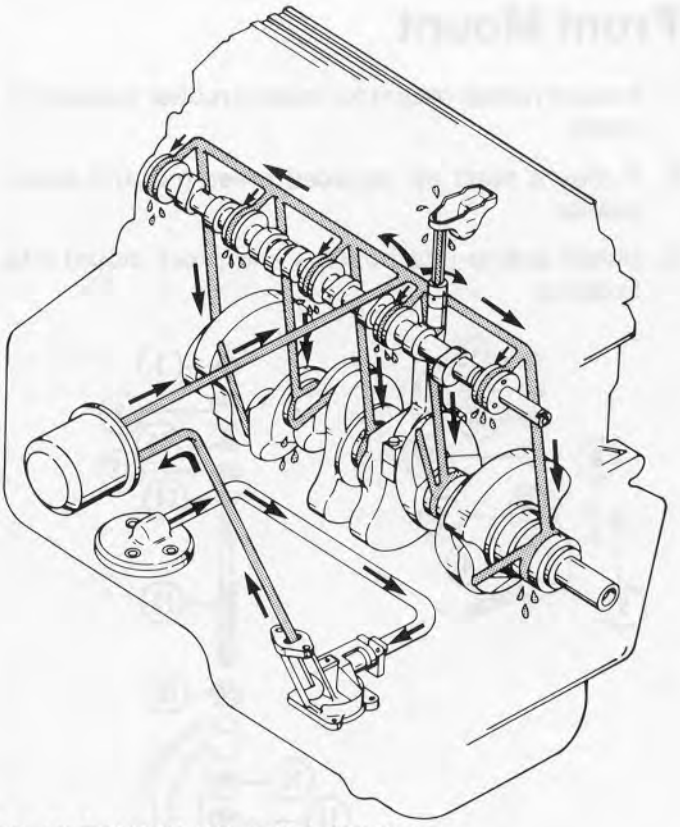
The oil is routed to the main oil galley, which is located above the camshaft and runs the entire length of the block. The oil is routed thru individual passages to each camshaft bearing bore. The remainder of the oil is routed to the valve lifter oil gallies and crankshaft main bearings.

The oil which reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows in between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings thru grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins.

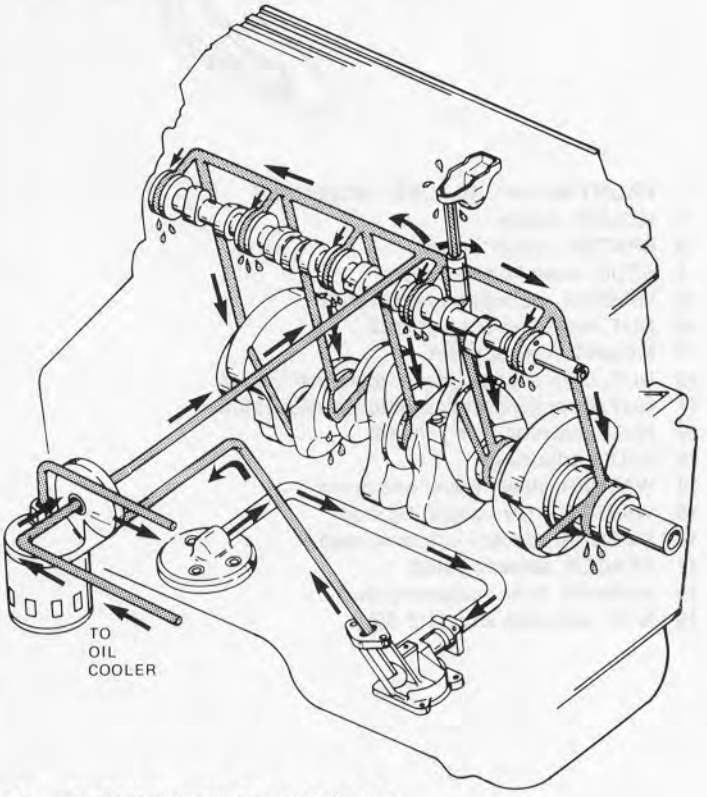
Oil which is forced out the front end of the crankshaft main bearing also assists in lubricating the camshaft drive.

Oil which reaches the valve lifters oil gallies is forced into each hydraulic valve lifter thru holes in the side of the lifter. The oil is forced thru the metering valve of the lifter and then thru the push rod to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass thru the rocker arm and lubricate the valve train bearing surfaces.

After lubricating the valve train, oil drains back to the oil pan through return holes in the head and block. The distributor shaft and gear is also lubricated by the oil flowing thru the valve lifter galley. The fuel pump push rod is lubricated by oil thrown off from the camshaft.



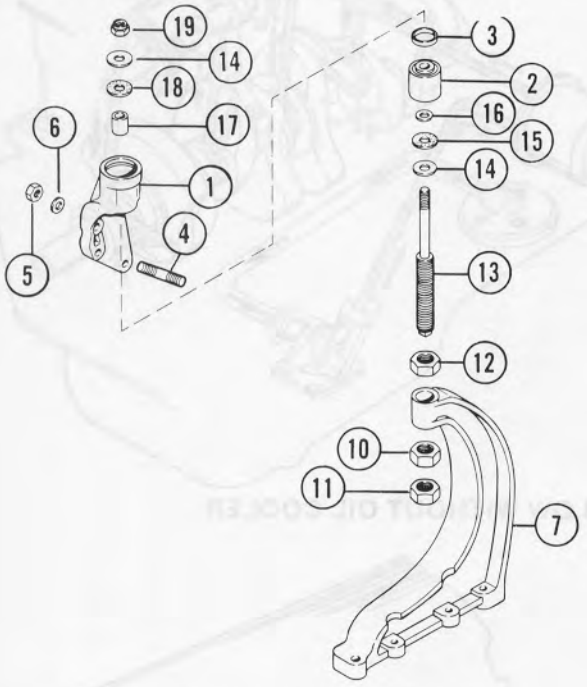
OIL FLOW WITHOUT OIL COOLER



OIL FLOW WITH OIL COOLER

Front Mount

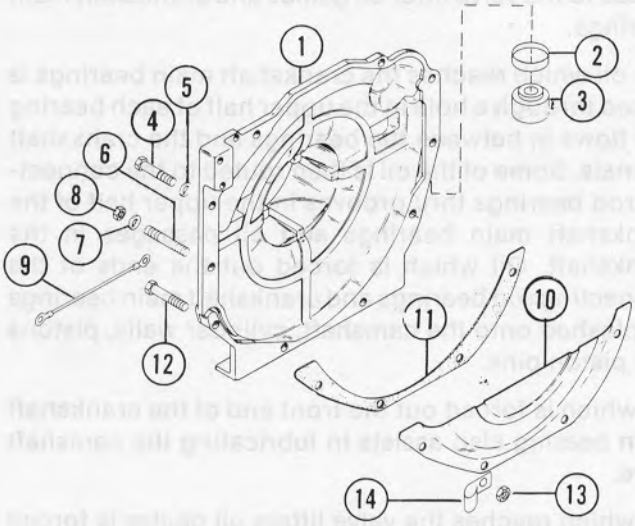
1. Inspect rubber mount for tears in rubber bonding to metal.
2. If mount must be replaced press out and retain spacer.
3. Install spacer into housing and press mount into housing.



1 FRONT MOUNT BRACKET ASSEMBLY
2 MOUNT, rubber
3 SPACER, rubber mount
4 STUD, mounting bracket
5 WASHER, mounting bracket stud
6 NUT, mounting bracket stud
7 MOUNT, front support
10 NUT, front support mount to adjusting stud
11 NUT, front support mount to adjusting stud
12 NUT, adjusting stud (7/8-14)
13 STUD, adjusting
14 WASHER, steel - upper and lower
15 WASHER, fiber - adjusting stud
16 WASHER, spacer - adjusting stud
17 SPACER, adjusting stud
18 WASHER, fiber - adjusting stud
19 NUT, adjusting stud (1/2-20)

Rear Mounts/Flywheel Housing

1. Inspect rubber mounts for tears in rubber bonding to metal.
2. If rubber mounts must be replaced, press out and retain spacer.
3. Install spacer into housing and press mounts into housing.



1 FLYWHEEL HOUSING ASSEMBLY
2 SPACER, rubber mount
3 MOUNT, rubber
4 SCREW, flywheel housing (1-1/4")
5 LOCKWASHER, flywheel housing screw
6 STUD, flywheel housing
7 LOCKWASHER, flywheel housing stud
8 NUT, flywheel housing stud
9 WIRE, flywheel housing stud
10 COVER, flywheel housing
11 GASKET, flywheel housing cover
12 SCREW, cover to flywheel housing and clamp (1")
13 NUT, cover to flywheel housing and clamp screw
14 CLAMP, shift cable attaching

Rocker Arm Cover

REMOVAL

1. Remove spark plug leads.
2. Disconnect crankcase ventilation hose at rocker arm cover.
3. Remove throttle cable (some models).
4. Remove attaching bolts.
5. Remove rocker arm cover and gasket.

CLEANING and INSPECTION

1. Wash cover in solvent and dry with compressed air.
2. Remove all gasket material.
3. Inspect all gasket surfaces.

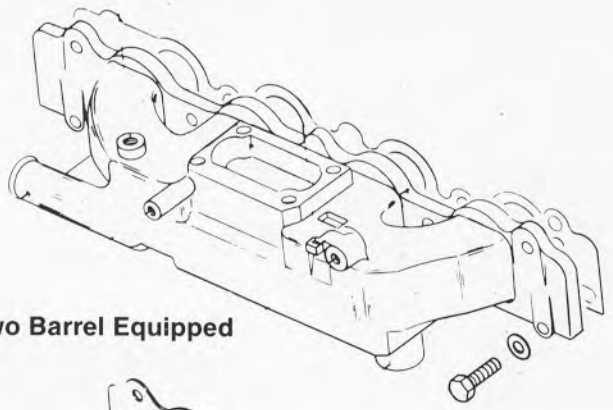
INSTALLATION

1. Use a new gasket and install rocker arm cover and torque to specifications.
2. Connect all parts previously removed.

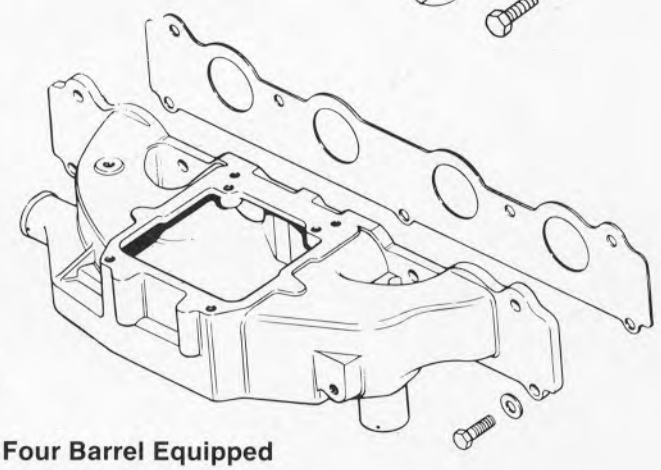
Intake Manifold

REMOVAL

1. Remove manifold assembly and discard gasket.



Two Barrel Equipped

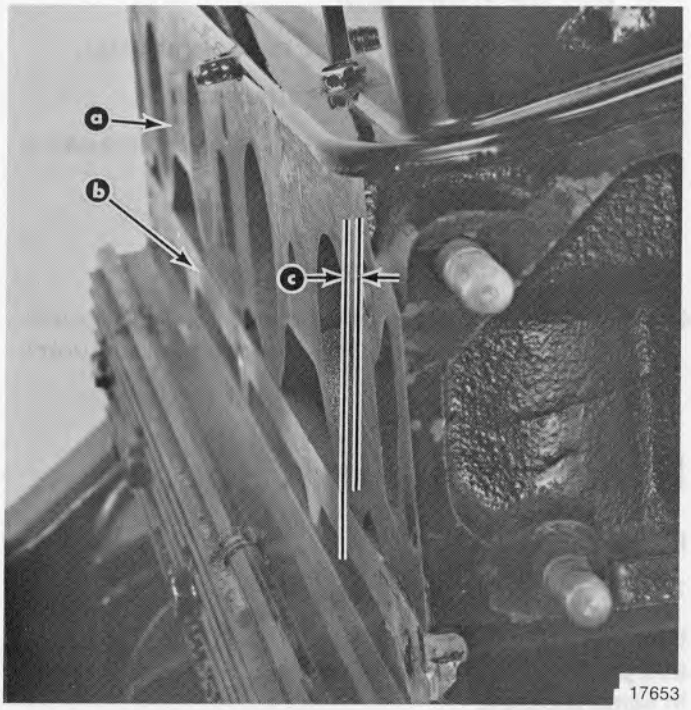


Four Barrel Equipped

CLEANING and INSPECTION

1. Remove all gasket material.
2. Clean manifold in a suitable solvent and dry with compressed air.
3. Inspect manifold.
4. Inspect for misalignment of cylinder head and cylinder block.

IMPORTANT: Gap must be within specification or engine oil may be drawn into intake manifold. This in turn will cause engine to burn oil.



a - Cylinder Head Surface
b - Cylinder Block Surface
c - Maximum Gap .020" (.5mm)

5. If gap is more than specified, do either "a", "b" or "c".
   a. Remove cylinder head. Using new head gasket, reposition head until gap is within specifications.
   b. Use RTV Sealer on low surface, then put manifold gasket on.
   c. Replace cylinder head and recheck gap.

INSTALLATION

1. Apply Perfect Seal on both surfaces of intake manifold to cylinder head gasket. Position new gasket and intake manifold on cylinder head. Install fastener bolts with flat washers. Torque fasteners to specifications.
2. Use new gasket and install carburetor, if removed. Torque fasteners to specifications.
3. Connect the following:
   a. Water hoses to manifold.
   b. Fuel line to carburetor.
   c. Crankcase breather hose to flame arrestor.
   d. Fuel pump vent tube to carburetor.
   e. Carburetor linkage to manifold. Lubricate swivel points.
   f. Throttle cable.
   g. Connect wires to choke cover.
4. Pressure check the cooling system, using automotive radiator cap tester. Follow tool manufacturer's instructions.

Rocker Arm/Push Rod

REMOVAL

1. Remove rocker arm cover.

IMPORTANT: Place rocker arms, rocker arm fulcrums and push rods in a rack so that they may be reinstalled in same location.

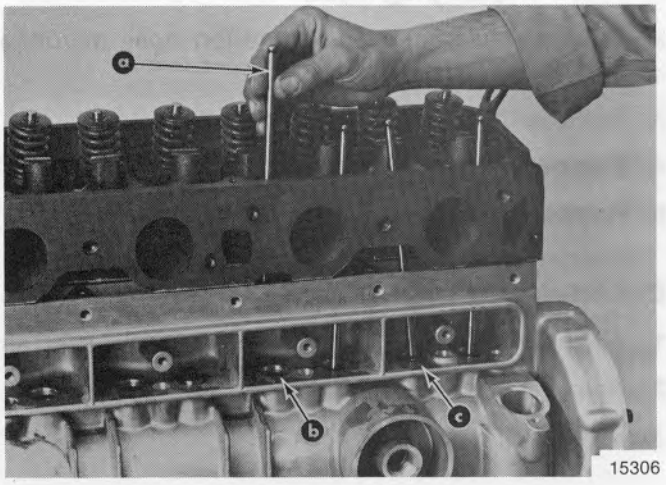
2. Remove rocker arm bolts, fulcrums, rocker arms and push rods.

CLEANING and INSPECTION

1. Clean parts in solvent and dry with compressed air.
2. Inspect each rocker arm for wear. Replace worn rocker arms.
3. Check push rod ends and fulcrum for excessive wear. Replace if necessary.
4. Check push rods for bent condition.

INSTALLATION

1. Install push rods. Be sure that push rods seat in lifter socket.



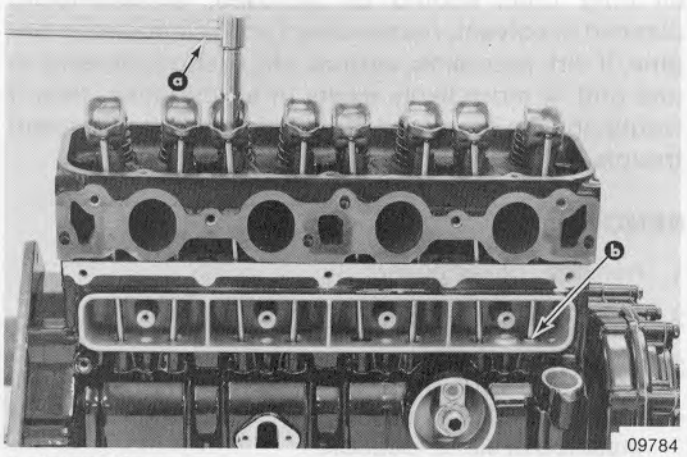
a - Push Rod
b - Lifter (Note Socket)
c - Push Rod Installed into Lifter Socket

2. Lubricate fulcrums and rocker arms with engine oil. Install rocker arms, fulcrums and rocker arm fastening bolts. Do not tighten bolts at this time.

TORQUING ROCKER ARM ATTACHING BOLTS

IMPORTANT: Torquing of rocker arm attaching bolt must be done with valve in closed position. Failure to do this can result in bent push rod.

1. Set #1 piston at TDC (firing) and torque the following rocker arm attaching bolts to 20 lbs. ft. (27.1 N.m).
   - #1 - Intake and Exhaust
   - #2 - Intake
   - #3 - Exhaust
   - #4 - Intake



a - Torque Wrench
b - Push Rods in Lifter Socket

2. Rotate the crankshaft 360° (1 complete revolution) and torque the following rocker arm attaching bolts to 20 lbs. ft. (27.1 N.m).
   - #2 - Exhaust
   - #3 - Intake
   - #4 - Exhaust

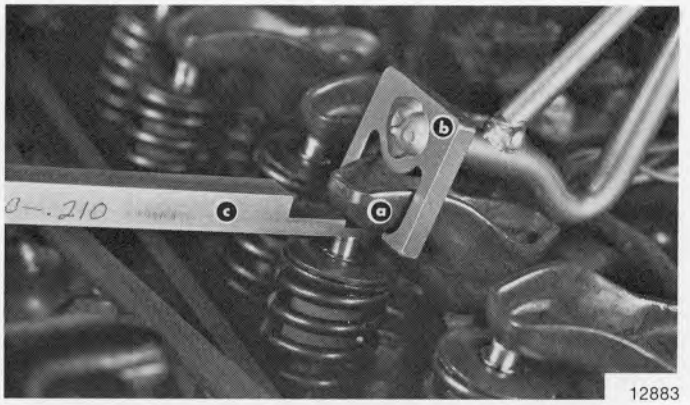
CHECKING VALVE CLEARANCE

IMPORTANT: Valve clearance is not adjustable. If clearance is not correct, it will be necessary to change the push rod to one of the correct length so that proper clearance can be achieved.

IMPORTANT: Checking valve clearance must be done with valve in closed position.

1. Set #1 piston at TDC (firing) and check the following valves.
   - #1 - Intake and Exhaust
   - #2 - Intake
   - #3 - Exhaust
   - #4 - Intake
2. Install valve lifter collapsing tool as shown. Firmly push on handle until lifter is completely collapsed.

   The correct clearance (distance between end of valve stem and face of rocker arm) is .110" - .210" (1.905 - 4.445mm).



a - Rocker Arm
b - Valve Lifter Collapsing Tool
c - Tool to Measure Clearance

If clearance is less than .110" (1.905mm), install a shorter push rod than was originally in engine.

If clearance is more than .210" (4.445mm), install a longer push rod. Select correct push rod from chart, following.

ENGINE PUSH ROD LENGTHS

Mercury Marine Part Number	Lengths	Color Code
67502--3	8.595" - 8.625" (218.313 - 219.075 mm)	Red
67502-T	8.655" - 8.685" (219.837 - 220.599 mm)	Blue
67502-T-1	8.625" - 8.655" (219.075 - 219.837 mm)	None
67502-T-2	8.685" - 8.715" (220.599 - 221.361 mm)	Yellow

3. Rotate the crankshaft 360° (1 complete revolution) and check the following valves.
   #2 - Exhaust
   #3 - Intake
   #4 - Exhaust

Hydraulic Valve Lifters

LOCATING NOISY LIFTERS

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

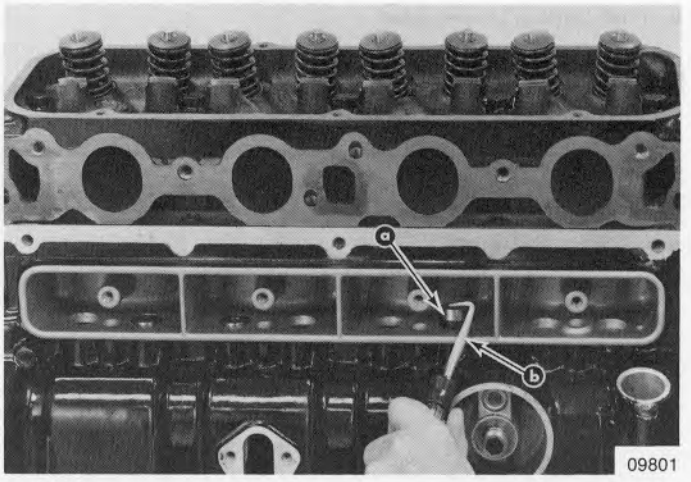
General types of valve lifter noise are as follows:

1. Hard rapping noise -- Usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise -- Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train -- This will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking -- Probable causes are:
   a. A piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc. is shown to exist in one unit, it more likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

REMOVAL

1. Remove rocker cover.
2. Remove valve mechanism.
3. Remove side cover.
4. Remove lifters, place in order so that they will be reinstalled in same location.



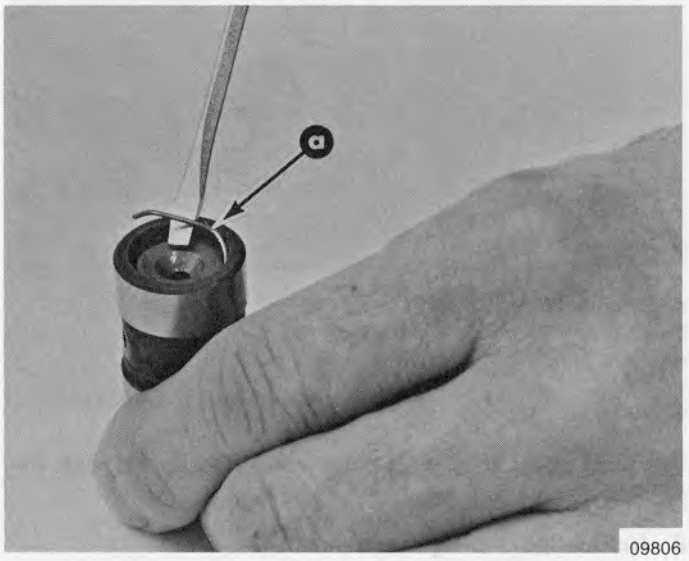
a - Lifter
b - Pointed Tool

DISASSEMBLY

IMPORTANT: Lifters can be disassembled, cleaned and reinstalled. If any parts are worn, lifter must be replaced as an assembly.

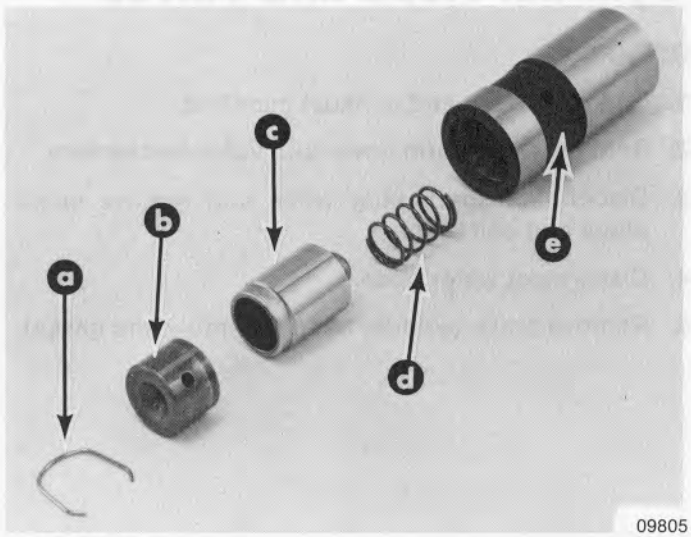
1. Use small screwdriver or needle-nose pliers to remove lockring.

⚠CAUTION
Use care when removing spring loaded lockring.



a - Lockring

2. Lightly tap top end of lifter assembly on flat surface to remove push rod cup, plunger/check valve assembly and spring.



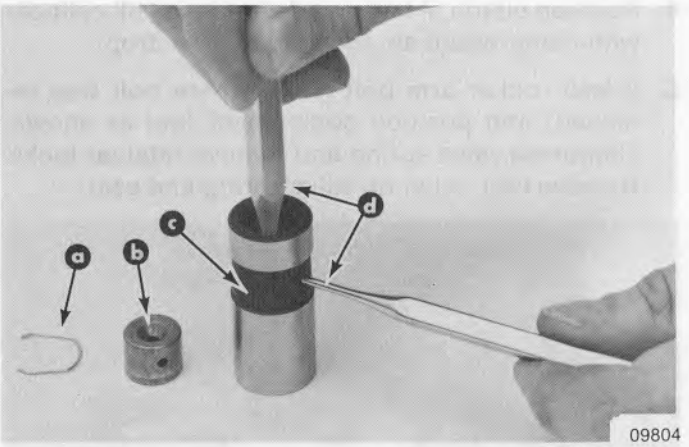
a - Lockring
b - Push Rod Cup
c - Plunger/Check Valve Assembly
d - Plunger Spring
e - Lifter Body

CLEANING and INSPECTION

1. Thoroughly clean all parts in cleaning solvent and dry them with compressed air.
2. Carefully inspect all parts. If any parts are damaged or worn, entire lifter assembly must be replaced. If outside of lifter body is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is worn, inspect camshaft lobe. If push rod seat is worn, inspect push rod.

REASSEMBLY

1. Fill lifter body with oil to approximately 1/2-full.
2. Set plunger spring in lifter body.
3. Place plunger assembly (check valve end down) in lifter body.
4. Use small punch to unseat check ball (located in bottom of plunger assembly) and push plunger (compressing spring) until top of plunger is below hole in side of lifter body. Insert small punch through side hole to hold plunger in position.



a - Lockring
b - Push Rod Cup
c - Lifter Body
d - Small Punches

5. Remove punch from check ball and position push rod cup in lifter body.
6. Install lockring in groove and remove punch from lifter body side hole.

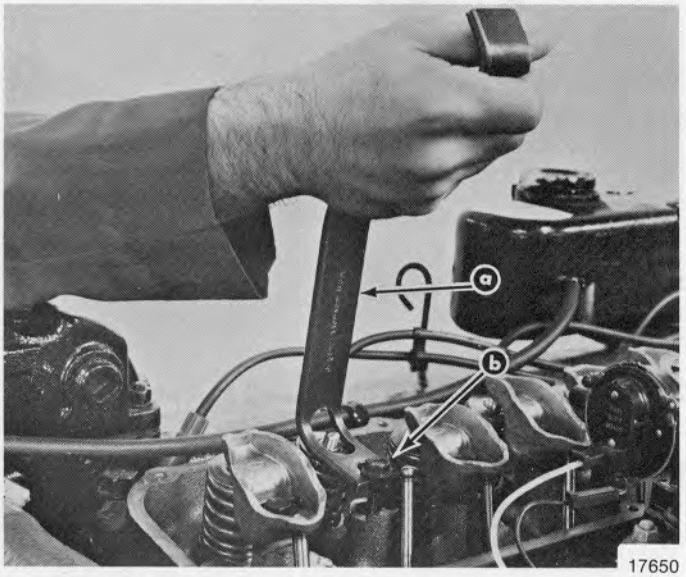
INSTALLATION

1. Lubricate all camshaft lobes, lifter bores and entire lifter with Engine Oil Supplement or engine oil.
2. Replace lifter into lifter bore from which it was removed.
3. Install valve mechanism.
4. Install cover, using new gasket and new "O" rings on cover attaching bolts. Torque to specifications.
5. Install rocker arm cover.

Valve Stem Oil Seal and/or Valve Spring

REMOVAL

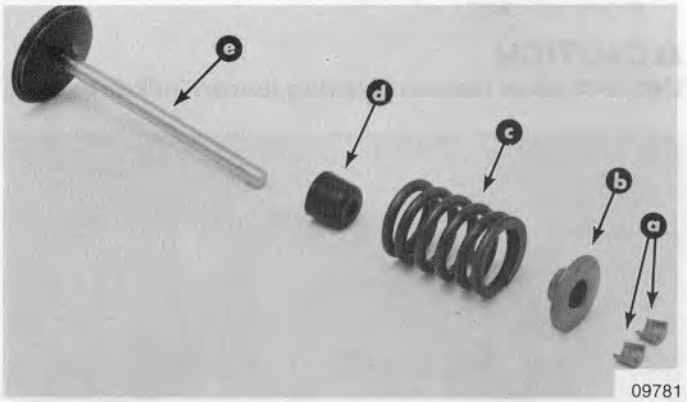
1. Remove rocker arm cover.
2. Remove spark plugs.
3. Remove rocker arm bolt, fulcrum, rocker arm and push rod on cylinder to be serviced.
4. Position piston at bottom of stroke and fill cylinder with compressed air, to prevent valve drop.
5. Install rocker arm bolt (from where bolt was removed) and position compressor tool as shown. Compress valve spring and remove retainer locks. Remove tool, retainer, valve spring and seal.



a - Tool - J-5892-1
b - Rocker Arm Bolt

INSTALLATION

1. Install new valve stem seal. Place spring in position over valve and install valve spring retainer. Compress valve spring and install spring retainer locks. Remove compressor tool and bolt.



a - Retainer Locks
b - Spring Retainer
c - Valve Spring
d - Seal
e - Valve

IMPORTANT: If new spring was installed, check installed spring height.

2. Install spark plugs and wires.
3. Install valve mechanism.
4. Install rocker arm cover.

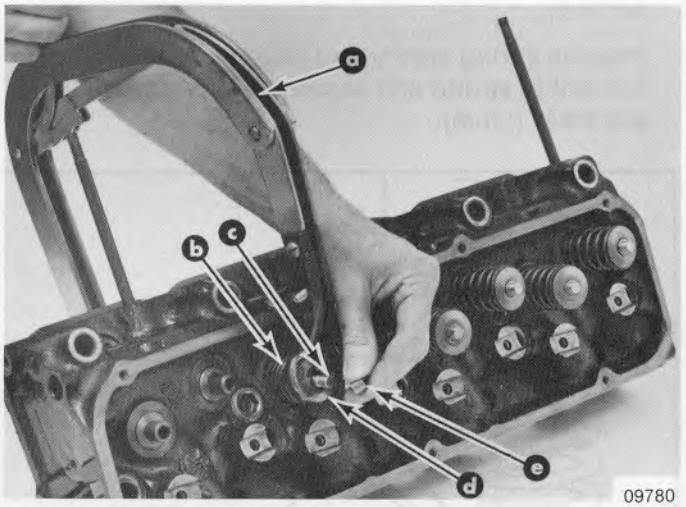
Cylinder Head and Valves

REMOVAL

1. Remove intake and exhaust manifold.
2. Remove rocker arm cover and valve mechanism.
3. Disconnect spark plug wires and remove spark plugs and coil bracket.
4. Disconnect water hose.
5. Remove bolts, cylinder head assembly and gasket.

DISASSEMBLY

1. Compress valve springs with valve spring compressor and remove valve retainer locks.

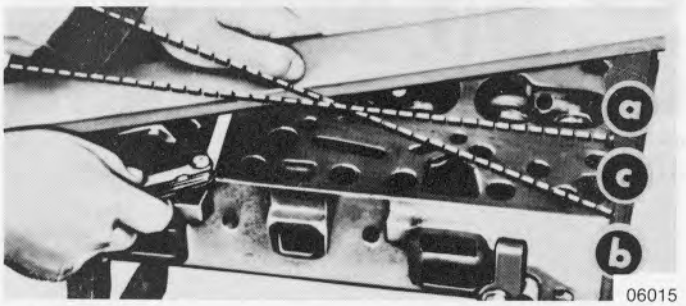


a - J-8062 Tool
b - Valve Spring
c - Valve Stem
d - Spring Retainer
e - Retainer Locks

2. Remove spring compressor tool, spring retainer, valve spring, valve stem seal and valve. Identify all valves to reinstall in same location.
3. Repeat Steps 1 and 2 to remove each valve.

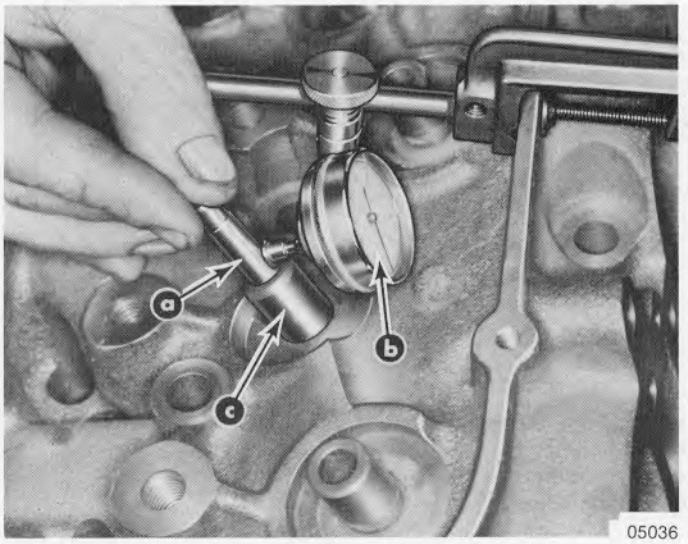
CLEANING and INSPECTION

1. Remove deposits from combustion chambers with Tool J-8089.
2. Clean all gasket surfaces.
3. Thoroughly clean valve guide bores with valve guide cleaning tool.
4. Clean all bolts and bolt holes.
5. Check cylinder head for cracks and inspect gasket surface for burrs and nicks.
6. Check cylinder head for flat gasket surface.



a - Check Diagonally
b - Check Diagonally
c - Check Across Center

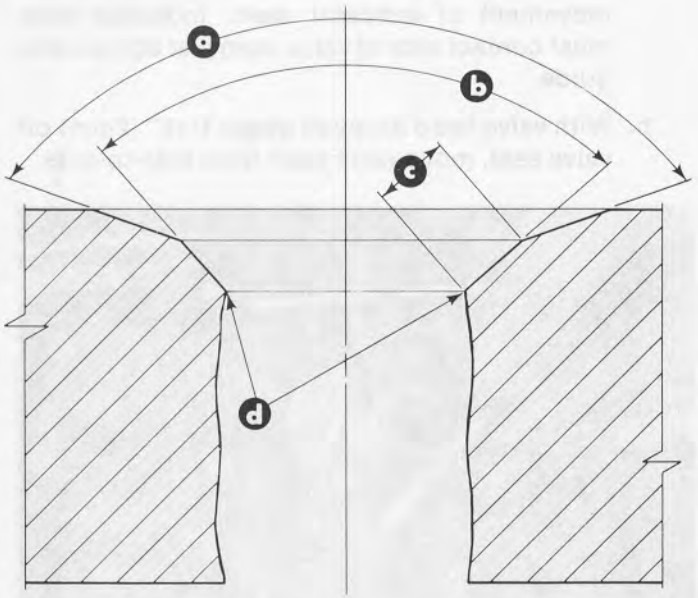
7. Measure valve stem clearance as follows:
   a. Clamp dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to head) will cause direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide.
   b. With valve head dropped about 1/16" (2mm) off valve seat, move valve stem from side-to-side.



a - Valve Stem
b - Dial Indicator
c - Valve Guide

8. Check valve seat for runout.
   a. Install accurate gauge on tool positioned in valve stem guide. It is essential that valve guide bores are free of carbon or dirt.
   b. Follow instructions of gauge manufacturer. If runout exceeds wear limit, reface valve and valve seat.

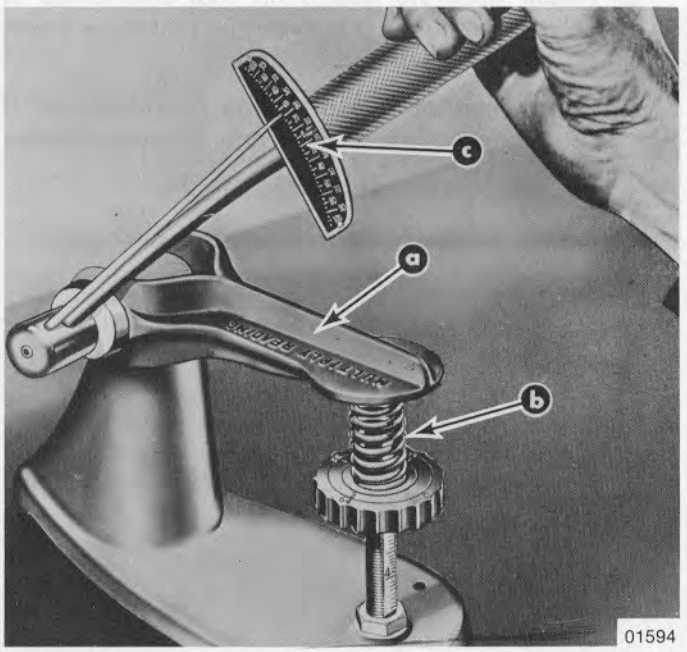
9. Check valve seat width.
   a. Measure valve seat width.
   b. Reface valve seat if not within specifications.



a - Top Edge "Approach Angle"
b - Seat Angle
c - Seat Width
d - Bottom Edge

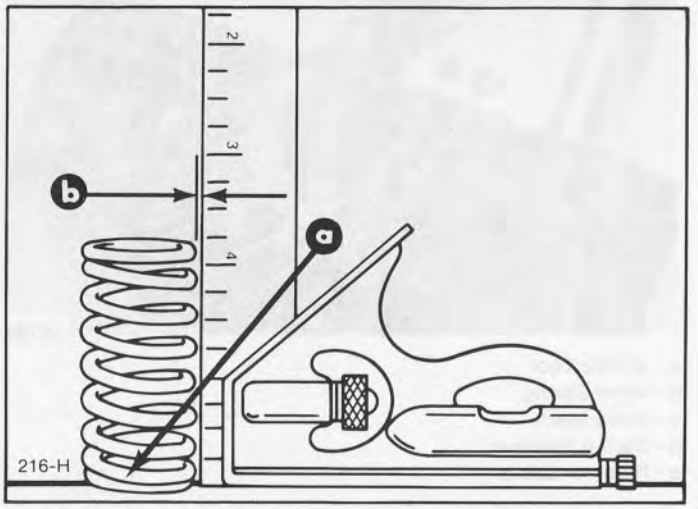
VALVE SPRING INSPECTION

1. Check springs for correct pressure at specified spring lengths with Tool J-8056. Follow tool manufacturer instructions.



a - J-8056 Tool
b - Valve Spring
c - Torque Wrench

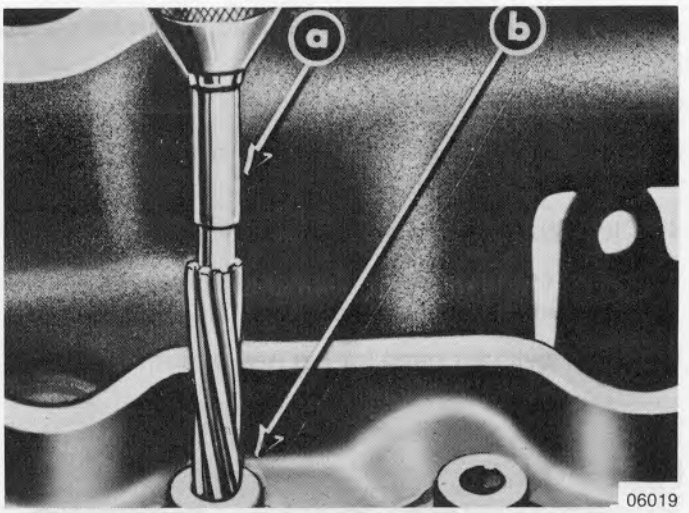
2. Replace any spring not within specifications.
3. Check each spring for "square". Stand spring (closed coil end downward) and steel square on flat surface.
4. Revolve spring slowly and observe space between top coil of spring and square. Out-of-square limits are 5/64" (2mm).



a - Valve Spring Closed Coil End
b - Max. 5/64" (2mm)

VALVE GUIDE BORE REPAIR

1. If clearance exceeds specifications ream valve guide for next oversize valve as shown.

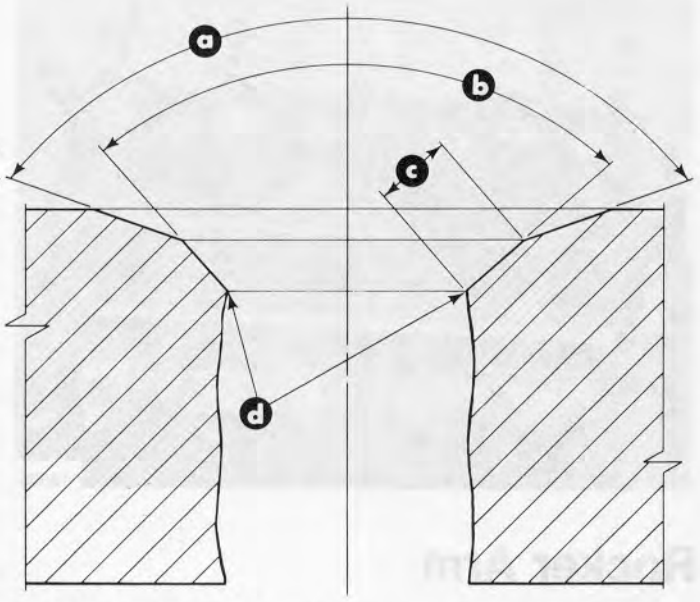


a - T52L-6085-AEE Tool
b - Valve Guide

2. Valve guide to be reamed must be refinished before doing any checking or refacing of valve seat.
3. After guide is refinished, seat also must be refaced to match guide.
4. Always use reamers in sequence (starting with smallest oversize reamer) when going from standard valve stem to an oversize.
5. Remove sharp corner (inside diameter) from top of valve guide.
6. Clean head assembly thoroughly.

VALVE SEAT REPAIR

1. Check valve seat for runout.
   a. Install accurate gauge on tool positioned in valve stem guide. It is essential that valve guide bores are free of carbon or dirt.
   b. Follow instructions of gauge manufacturer. If runout exceeds wear limit, reface valve and valve seat.
2. Measure valve seat width (see "Specifications").



a - Top Edge "Approach Angle"
b - Seat Angle
c - Seat Width
d - Bottom Edge

3. Grind valve seats to correct angle (see "Specifications"). Remove only enough stock to clean up pits and grooves or to correct valve seat runout.
4. Finished valve seat must contact appropriate center of valve face. Apply ink (with felt tip pen) to refinished valve face. Install valve and rotate with light pressure. Remove valve and check seat contact. If seat contacts center of valve face, contact is satisfactory. If seat contact is at top edge of valve face, lower the valve seat. If seat contact is at bottom edge of valve face, raise the valve seat.
5. After seat has been refaced, recheck seat width. If width exceeds maximum limit, remove enough stock from top edge and/or bottom edge of seat to reduce width to specifications.
6. If valve and/or seat has been refaced, check clearance between rocker arm seat and valve stem. Refer to "Valve Clearance".

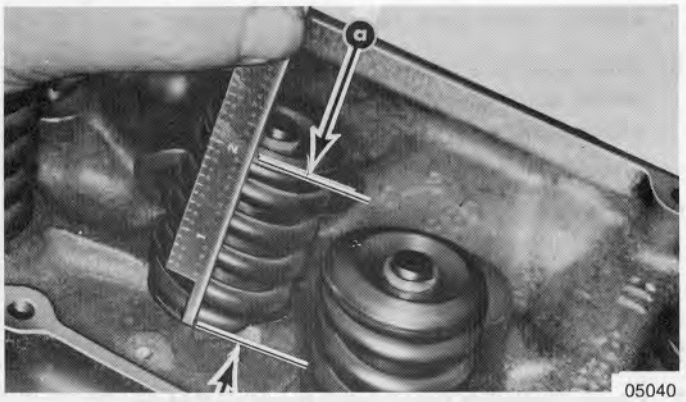
VALVE REPAIR

1. Clean deposits from valve head and stem.
2. Coordinate valve refacing operation with valve seat refacing so that finished angles provide compression-tight fit.
3. See "Specifications", for valve face angle. Remove only enough stock to correct runout or to clean up pits and grooves. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace valve.
4. If valve and/or seat has been refaced, check clearance between rocker arm seat and valve stem. Refer to "Valve Clearance".

REASSEMBLY

1. Lubricate valve stem and valve stem guide with Engine Oil. Install each valve in port from which it was removed or to which it was fitted.
2. Install new stem seal on valve.
3. Install valve spring, and spring retainer.
4. Compress spring (using compressor tool) and install retainer locks. Make sure that locks are positioned properly in valve stem groove.

5. Measure assembled height of valve spring from surface of cylinder head spring seat to underside of spring retainer. If assembled height is greater than specifications, install spacer(s) below spring to reduce height to recommended dimenesion. Do not overshim.



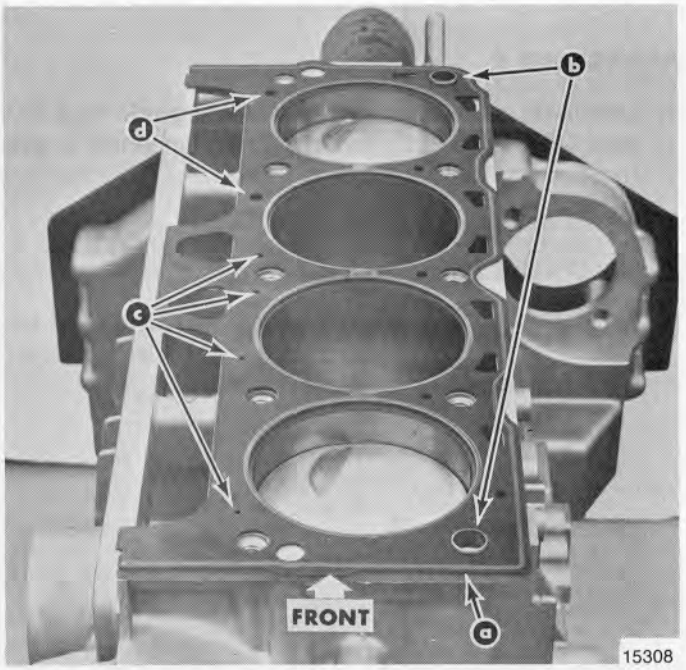
a - See "Specifications"

INSTALLATION

1. Be sure that all gasket surfaces are clean.

IMPORTANT: Do not use any gasket cement or sealer on Head Gasket, Cylinder Head or Cylinder Block.

2. Position new cylinder head gasket on cylinder block with the word "front" (stamped on gasket) toward front of engine facing "down" toward cylinder block.



a - Cylinder Head Gasket
b - Alignment Dowel Pins
c - Small Water Passage Holes
d - Large Water Passage Holes

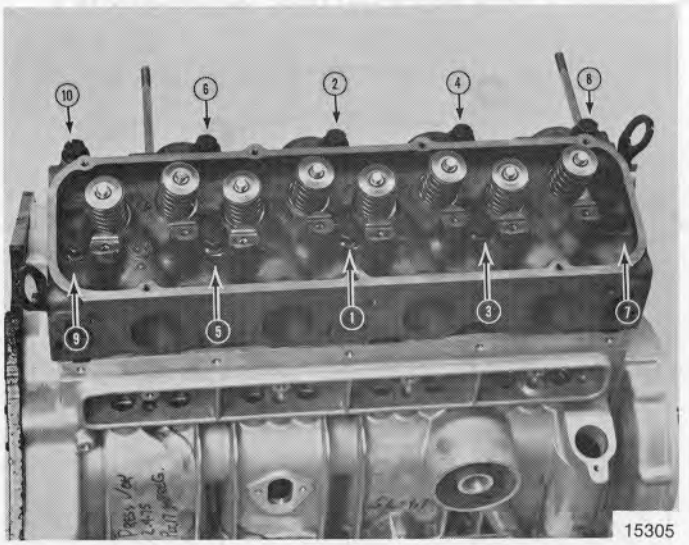
IMPORTANT: Check alignment of cylinder head and cylinder block as outlined under "Intake Manifold".

3. Coat threads and underside of bolt head with Perfect Seal and install cylinder head bolts.

⚠CAUTION

Failure to properly torque cylinder head bolts will result in very short head gasket life. Cylinder head bolt holes (located in cylinder block) must be free of water or oil when installing cylinder head fastening bolts. Block failure may occur from hydraulic pressure build-up while torquing cylinder head bolts. Also, cylinder head bolts must be retorqued after engine has been brought to normal operating temperature. Failure to do this can result in head gasket failure.

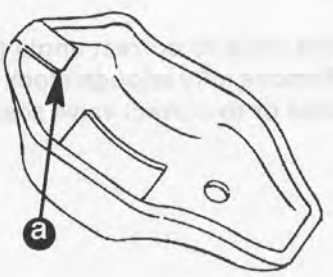
4. Follow torquing sequence, torque cylinder head bolts in three steps:
   a. 55 lbs. ft. (75 N.m)
   b. 90 lbs. ft. (122 N.m)
   c. 130 lbs. ft. (176 N.m)



Rocker Arm

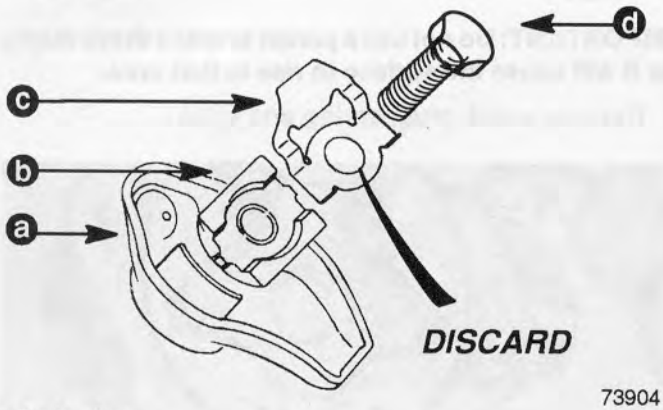
The later rocker arm has an oil baffle as a integral part of the rocker arm.

LATER STYLE



a - Oil Baffle

NOTE: The earlier style baffle must not be used with the later style rocker arm.



a-Rocker Arm
b-Ball
c-Baffle
d-Screw

Oil Pan

REMOVAL

1. Drain crankcase oil.
2. Remove oil dipstick and dipstick tube.
3. Remove attaching bolts, washers and oil pan.

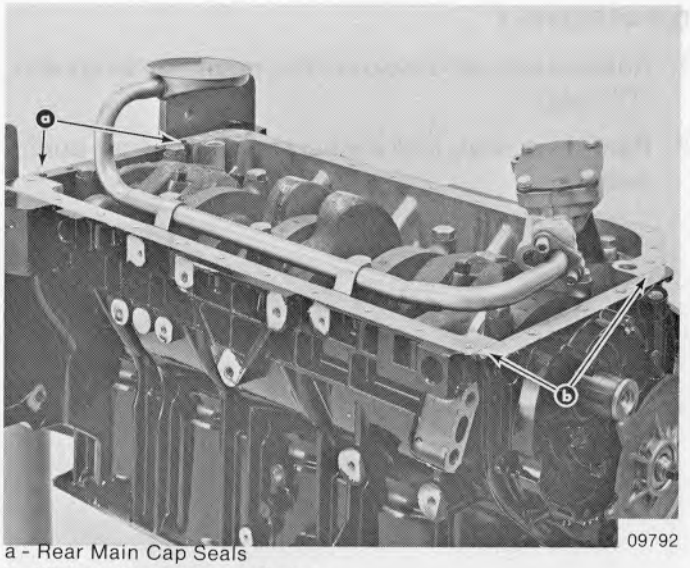
CLEANING and INSPECTION

1. Clean gasket surfaces.
2. Wash pan in solvent and dry thoroughly.
3. Check pan for damage.
4. Replace pan if repairs cannot be made.

INSTALLATION

IMPORTANT: Timing cover must be installed before installation of oil pan.

1. Coat gasket surfaces of block and oil pan with Perfect Seal. Apply sealer thicker in area on block where timing cover meets block and on rear main cap seals.



a - Rear Main Cap Seals
b - Timing Cover Mating Surface

2. Position new gasket on cylinder block gasket surface.
3. Position oil pan and install attaching bolts. Torque bolts to specifications from center outward in each direction. Retorque bolts a second time.

Oil Pump

IMPORTANT: Late model oil pumps have a cast iron body instead of the older style aluminum. The pumps are interchangeable, but must have the correct oil pick-up tube assembly.

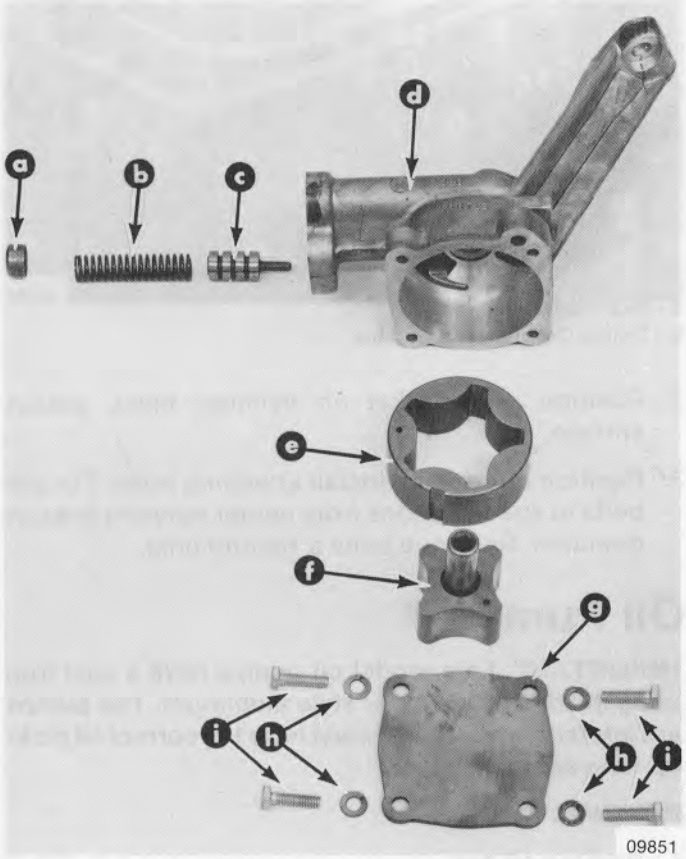
REMOVAL

1. Remove oil pan.
2. Remove bolts from oil pump pickup tube clamps and pump attaching bolts.

a - Tube Clamp Bolts
b - Pump Bolts

DISASSEMBLY

1. Remove bolts and pickup tube, retaining flange and "O" ring.
2. Remove screws, lockwashers and cover from pump body.

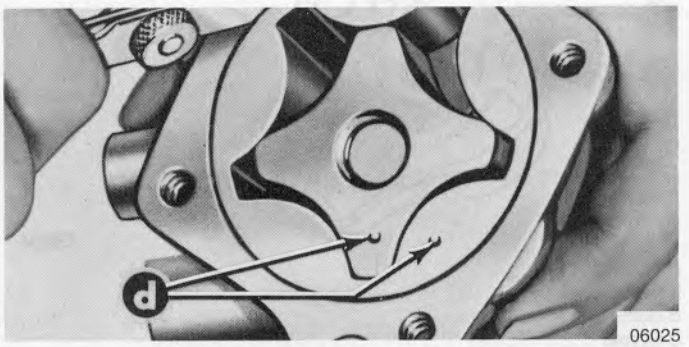


a - Welch Plug
b - Relief Valve Spring
c - Relief Valve Plunger
d - Pump Housing
e - Outer Rotor
f - Inner Rotor
g - Cover
h - Lockwasher
i - Screw

3. Inner and outer rotors each have identification marks on one side. (If there aren't any marks make 2 as shown.) After installation, these 2 points must appear on the same side. Remove inner and outer rotor.

IMPORTANT: Do not use a punch to make these marks as it will cause the surface to rise in that area.

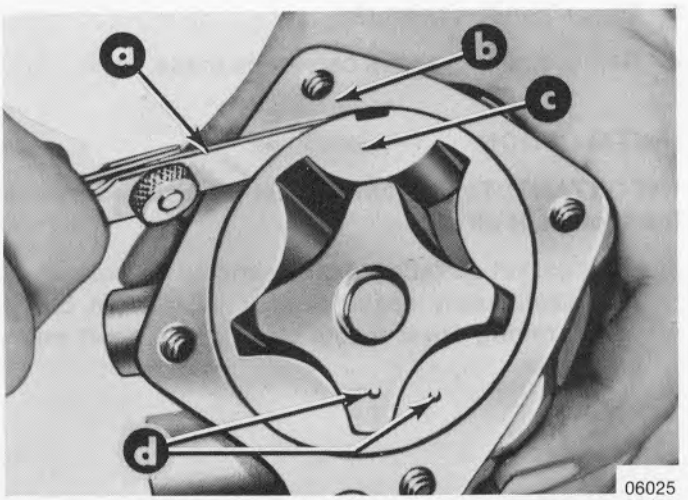
4. Remove welch plug, spring and valve.



d - Identification Marks

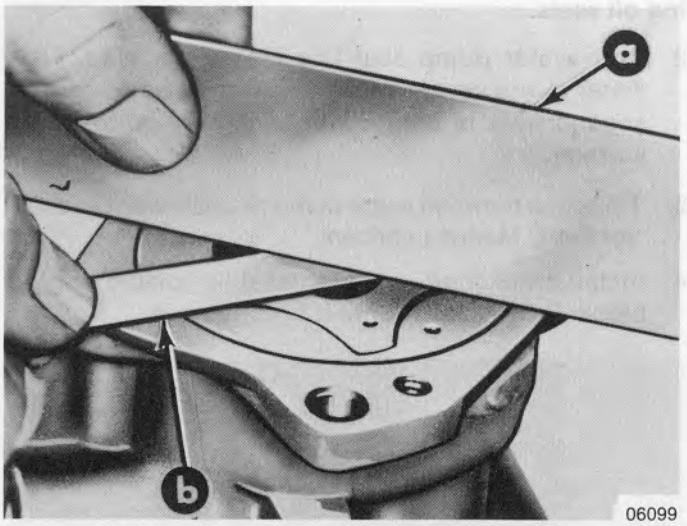
CLEANING and INSPECTION

1. Wash all parts in solvent. Dry parts thoroughly with compressed air.
2. Check inside of pump housing, outer rotor and inner rotor for damage or excessive wear.
3. Replace cover if rotor mating surface on cover is damaged.
4. Measure outer race to housing clearance, .001" to .0125" (.02mm to .3mm) as shown.



a - Feeler Gauge
b - Housing
c - Outer Race
d - Identification Marks

5. With rotor assembly installed in pump housing, place a straight edge over rotor assembly and pump body. Measure clearance (rotor end play) between straight edge and rotor, .001" to .005" (.02mm to .1mm).



a - Straight Edge
b - Feeler Gauge

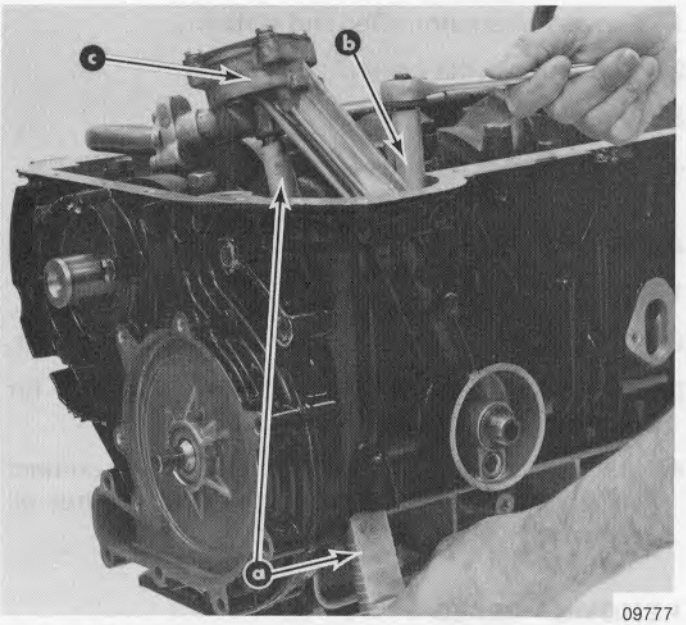
6. Check drive shaft to pump housing clearance by measuring OD of shaft and ID of housing cavity, .0015" to .0025" (.0381mm to .0635mm).
7. Inspect relief valve piston for scores and free operation in bore.
8. Inspect relief valve spring for collapsed or damaged condition.

REASSEMBLY

1. Oil all parts thoroughly.
2. Install oil pressure relief valve plunger, spring and new welch plug. Plug should be installed, open end out, flush with pump housing.
3. Install outer and inner rotor and shaft assembly. Be sure that identification mark on outer and inner rotor is facing the same direction.
4. Install cover and torque cover screws to specifications.
5. Position "O" ring and install pickup tube, its retaining flange (flat surface against pump housing) and fastening bolts. Torque bolts to specifications.

INSTALLATION

1. Position oil pump onto cylinder block and loosely install bolts.
2. Install Oil Pump Alignment Tool thru distributor hole and into oil pump drive.
3. Torque oil pump bolts to specifications.



a - Tool (91-14822)
b - Torque Pump Bolts
c - Oil Pump

4. Fasten oil pump pickup tube to cylinder block in 2 places, using clamps and screws. Torque screws to specifications.
5. Install oil pan.

Crankcase Front Cover and Oil Seals

REMOVAL - FRONT COVER ASSEMBLY

IMPORTANT: Oil pan gasket must be replaced whenever front cover is removed.

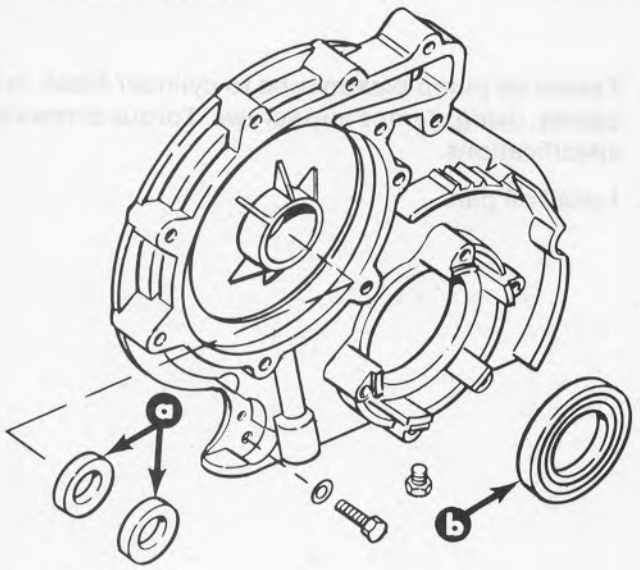
1. Remove alternator rotor and stator.
2. Remove impeller cover.
3. Remove impeller.
4. Remove front cover assembly.

CLEANING and INSPECTION

1. Clean all gasket surfaces.
2. Clean parts in solvent and dry with compressed air.
3. Inspect oil seals for wear. Inspect impeller for damage.
4. Inspect surface of shaft where oil seal lips contact shaft. Any groove in shaft in this area requires oil seal and shaft replacement.

REMOVAL - SEALS

1. Drive seals from casting being careful not to damage seal seat area.



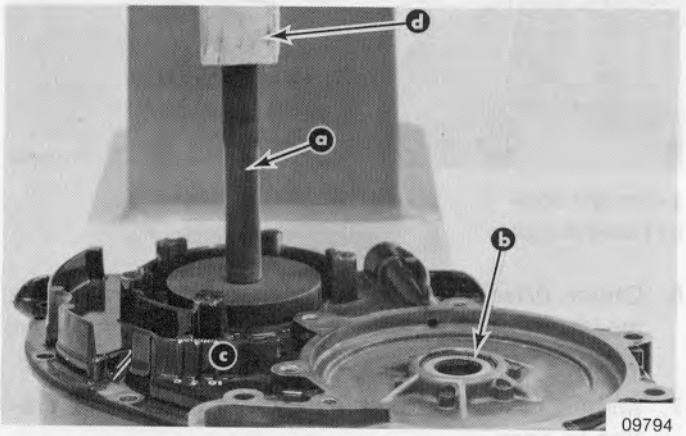
a - Water Pump Seal
b - Front Seal

INSTALLATION

1. Apply Loctite 8831 to outside diameter of all oil seals. Do not allow loctite on lip of seals.

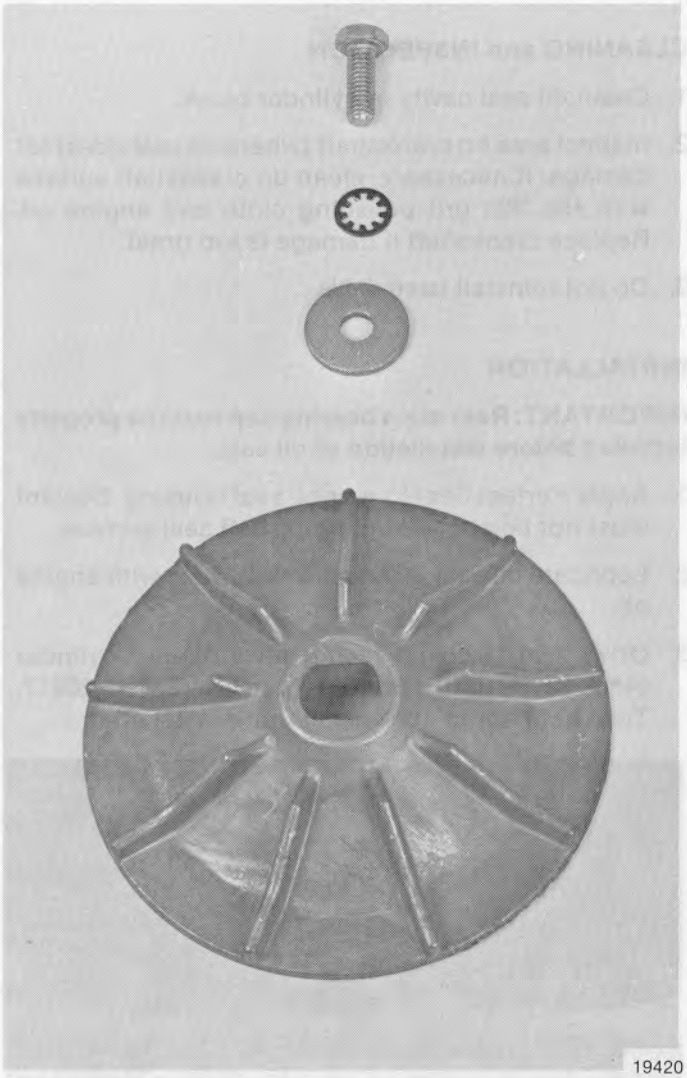
IMPORTANT: Support underside of cover when installing oil seals.

2. Both water pump seal lips face water side. First water pump seal is pressed in until it bottoms out; second seal is pressed in until even with cover surface.
3. Fill space between water pump oil seals with Quicksilver 2-4-C Marine Lubricant.
4. Install crankshaft seal with seal lip toward engine block. Press seal in until it bottoms-out.



a - Tool
b - Water Pump Shaft Oil Seals
c - Front Cover
d - Arbor Press

5. Lubricate seal lip with 2-4-C Marine Lubricant.
6. Lubricate crankshaft end and water pump shaft with 2-4-C Marine Lubricant.
7. Old style impeller with screw.
   a. Apply Loctite 8831 to screw threads and install screw, locking washer, large flat washer and impeller.



19420

OLD STYLE

   b. Torque screw to specifications.

8. New style impeller with stud.
   a. Apply Loctite 8831 to threads in camshaft.
   b. Install stud and torque to specifications.

IMPORTANT: Do not apply loctite to impeller threads.

   c. Thread impeller onto stud and torque to specifications.

19420

NEW STYLE

9. Using new gasket, install bolts and torque to specifications.
10. Apply Perfect Seal to gasket and bolt threads.
11. Install stator and alternator rotor. Reinstall front engine mount.

Flywheel and Coupler

REMOVAL

1. Remove flywheel housing.
2. Remove coupler.
3. Remove flywheel.

INSPECTION

Engine Coupling

1. Check coupling spline for wear. Coupling wear is caused by insufficient lubrication at time of installation.
2. Inspect hub bond. Bonding, that shears or pulls loose from hub center, indicates engine/drive misalignment.

Flywheel

Inspect ring gear for worn, chipped or cracked teeth. If teeth are damaged, replace flywheel.

INSTALLATION

1. Install flywheel (aligning offset holes) on crankshaft: Torque flywheel bolts to specifications.
2. Install engine coupler. Torque to specifications with torque wrench and Tool (91-35547).
3. Install flywheel housing and housing attaching parts.
4. Lubricate coupler splines with Quicksilver 2-4-C Marine Lubricant and install engine in boat.

Oil Seal (Rear Main)

REMOVAL

1. Remove flywheel.
2. Pry old oil seal from cylinder block assembly. Take care that crankshaft seal surface is not damaged by tool.

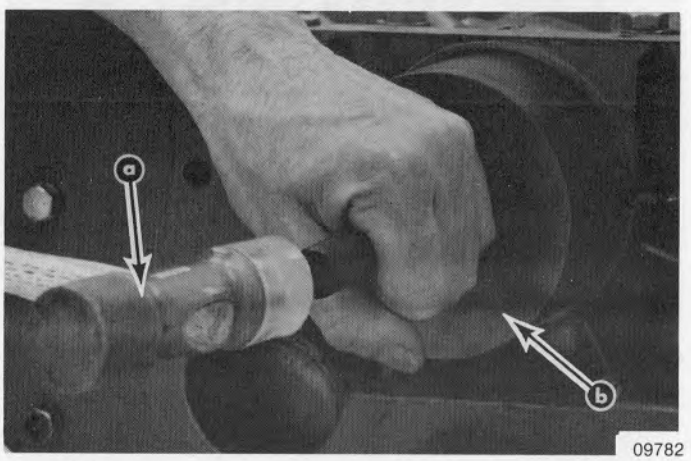
CLEANING and INSPECTION

1. Clean oil seal cavity in cylinder block.
2. Inspect area on crankshaft (where oil seal rides) for damage. If necessary, clean up crankshaft surface with No. 320 grit polishing cloth and engine oil. Replace crankshaft if damage is too great.
3. Do not reinstall used seals.

INSTALLATION

IMPORTANT: Rear main bearing cap must be properly installed before installation of oil seal.

1. Apply Perfect Seal to rear oil seal housing. Sealant must not be applied on crankshaft seal surface.
2. Lubricate oil seal lip and crank surface with engine oil.
3. Drive seal (with lip facing inward) into cylinder block cavity until it bottoms-out. Use Tool J-26817. Take care not to cock seal during installation.

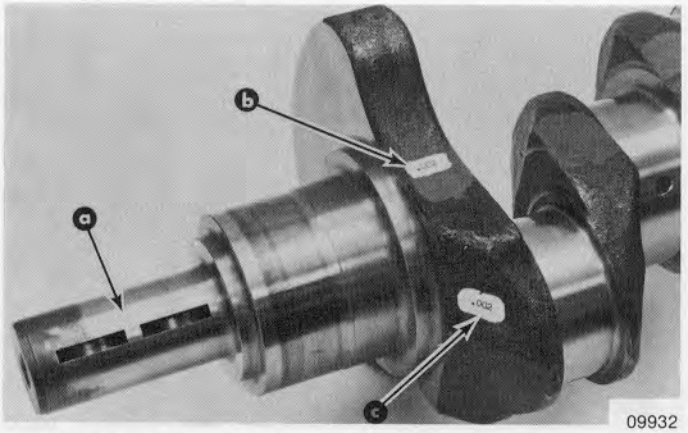


a - Mallet
b - J-26817 Tool

Main Bearings

Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are found to be excessive, a new bearing (both upper and lower halves) is required. Bearings are available in standard size and undersize.

When a production standard crankshaft journal cannot be precision-fit, it then is ground undersize on all main journals. .0___" will be stamped on crankshaft front counterweight, as shown.



09932

a - Front End of Crankshaft
b - Main Journal Mark Location
c - Rod Journal Mark Location

REMOVAL

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Place used bearings so that they can be installed in same location from where they were removed.

CLEANING and INSPECTION

Clean bearing inserts and caps thoroughly in solvent and dry with compressed air. Do not scrape gum or varnish deposits from bearing shells.

Inspect each bearing carefully. Replace bearings with scored, chipped or worn surface.

In general, lower half of bearing shows greater wear and most distress from fatigue. If lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing other half.

CHECKING CLEARANCE and INSTALLATION

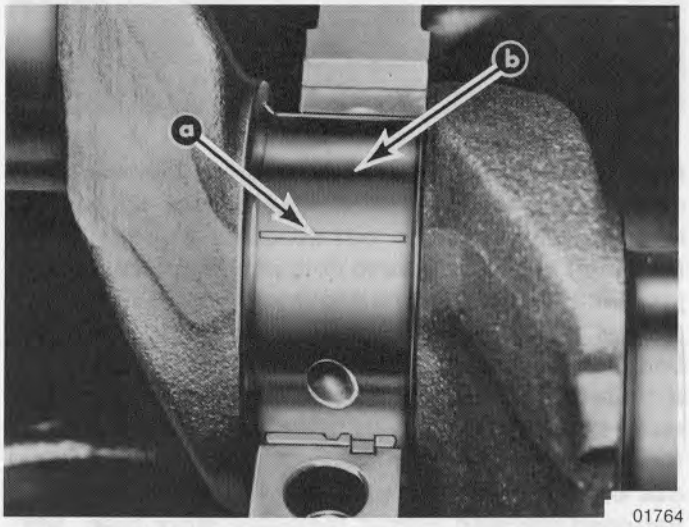
To obtain accurate results, use Plastigage (or its equivalent). The material must compress evenly between bearing and journal surfaces without damaging either surface.

1. With engine upside down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, torque all bearing cap bolts as specified.

2. Place piece of gauging plastic the full width of bearing (parallel to crankshaft) on journal.

⚠CAUTION
DO NOT rotate crankshaft while the gauging plastic is between bearing and journal.



01764

a - Gauging Plastic
b - Crankshaft Journal

3. Install bearing cap and torque retaining bolts evenly to specifications.
4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.

5. Edge of gauging plastic envelope has a graduated scale (in thousandths of an inch). Without removing gauging plastic, measure its compressed width (at widest point).

18302

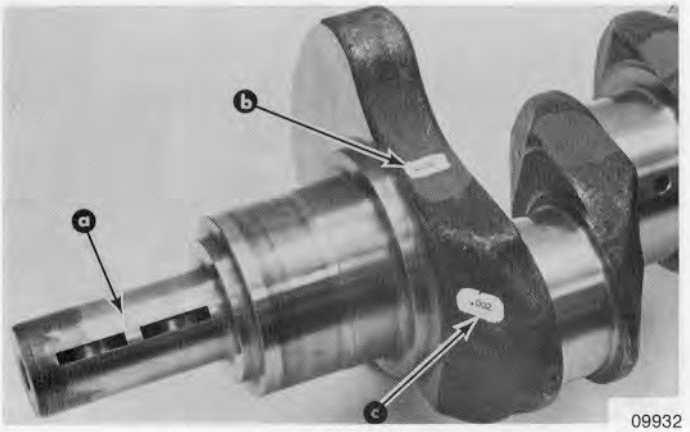
IMPORTANT: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal [.001" (.025mm) max.], be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance that indicates taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer, if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace inserts.
7. A standard or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing. Reinstall bearing cap.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft so that no excessive drag exists.
9. Measure crankshaft end play as outlined under "Crankshaft".
10. After bearing fit is correct, remove crankshaft and oil bearing surfaces and reinstall crankshaft.

Connecting Rod Bearings

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. Do not file rods or rod caps. If clearances are found to be excessive, a new bearing is required. Bearings are available in standard size and undersize.

When a production standard crankshaft journal cannot be precision-fit, it then is ground undersize on all rod journals. .0___" will be stamped on crankshaft front counterweight, as shown.



09932

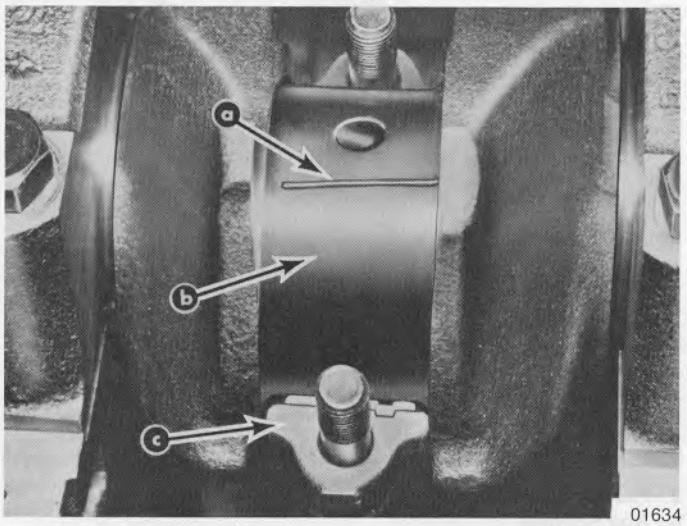
a - Front End of Crankshaft
b - Main Journal Mark Location
c - Rod Journal Mark Location

INSPECTION and REPLACEMENT

1. Lift off connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.

IMPORTANT: If bearing is being fitted to out-of-round crankpin, be sure to fit maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001" (0.025mm), interference between bearing and crankpin will result in rapid bearing failure.

5. Measure new or used bearing clearances with Plastigage or equivalent, as follows:
   a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft).



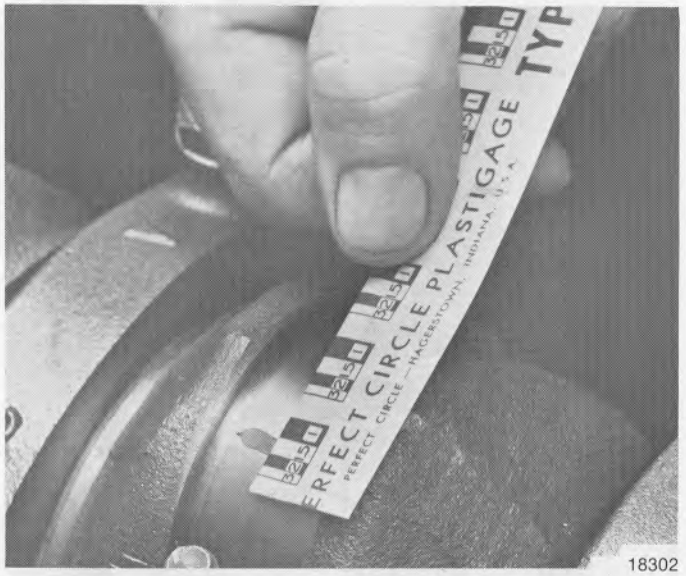
01634

a - Gauging Plastic
b - Crankpin
c - Connecting Rod

   b. Install bearing, connecting rod and cap. Take care that tab in bearing is located correctly in rod and rod cap notches.
   c. Install bearing cap and torque nuts evenly to specifications.

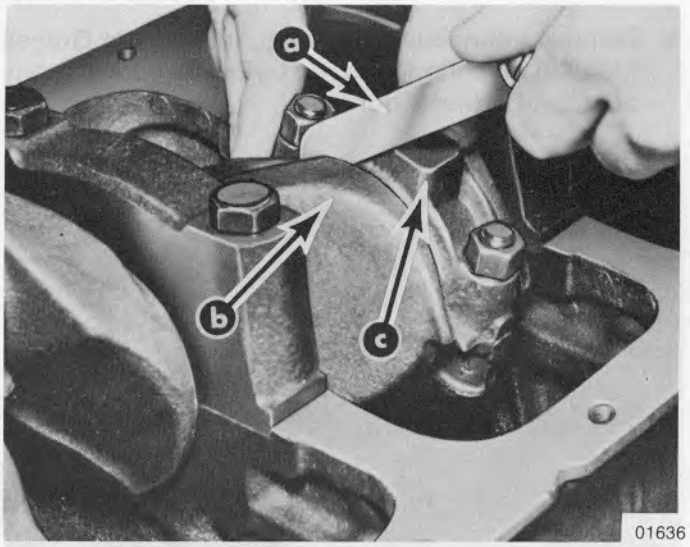
IMPORTANT: Do not turn crankshaft with gauging plastic installed.

   d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at widest point.



18302

6. If clearance exceeds specifications, select a new, correct-size bearing and re-measure clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to be sure that they have clearance.
9. Measure all connecting rod side clearances (see "Specifications") between connecting rod and side of crankpin.



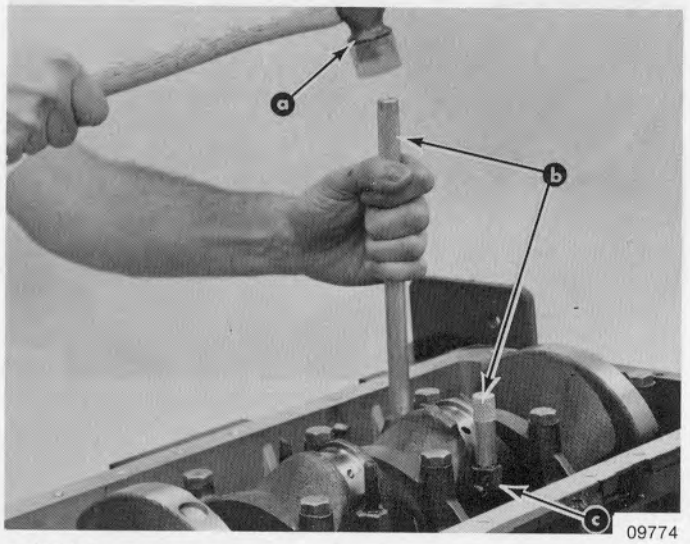
01636

a - Feeler Gauge
b - Crankshaft
c - Connecting Rod

Connecting Rod/Piston Assembly

REMOVAL

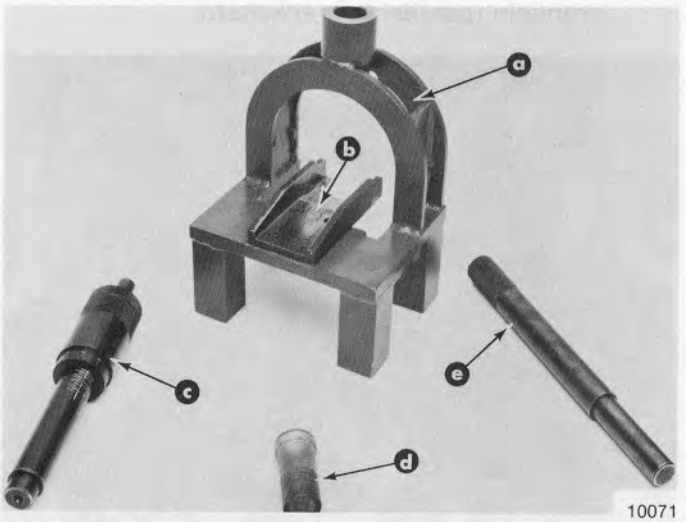
1. Remove flywheel housing and flywheel.
2. Remove cylinder head assembly.
3. Remove oil pan and oil pump.
4. Check connecting rod caps for cylinder number identification. If necessary, mark rod caps and rods.
5. Remove connecting rod caps. Install Rod Guides (J-5239) on connecting rod bolts and push pistons out top of cylinder bores.



a - Mallet
b - Rod Guide Tool
c - Connecting Rod

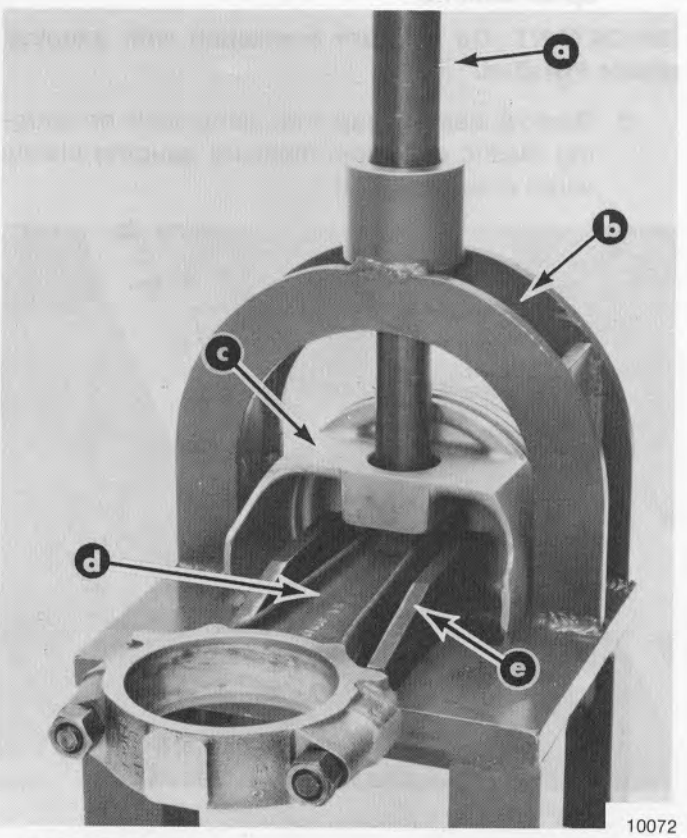
DISASSEMBLY

1. Use Tool Kit (J-24086-100), shown.



a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
e - Piston Pin Remover

2. Position connecting rod onto tool rod support, as shown.
3. Insert pin remover, as shown. Use a press to remove pin.



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

CLEANING and INSPECTION

Connecting Rods

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for cracks. (See "Specifications".) Replace damaged rods.

Pistons

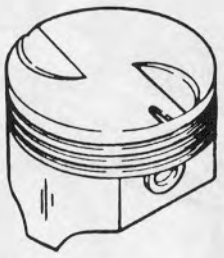
1. Clean varnish from piston skirts and pins with cleaning solvent. Do not wire brush any part or piston.
2. Clean ring grooves with groove cleaner.
3. Inspect piston. Replace pistons which are damaged or have excessive wear.
4. Inspect piston ring grooves.
5. Measure piston and check clearance as outlined under "Piston Selection - Cylinder Block".

Piston Pins

1. Piston and piston pin are matched and not serviced separately.
2. Pin bores and piston pins must be free of varnish or scuffing. Measure piston pin with micrometer and piston pin bore with bore gauge or inside micrometer. If clearance is in excess of wear limit (see "Specifications"), replace piston and pin assembly.

REASSEMBLY

1. Two different piston types may be encountered.
   a. Cast pistons with a notch in the top.



   b. Forged pistons without a notch.

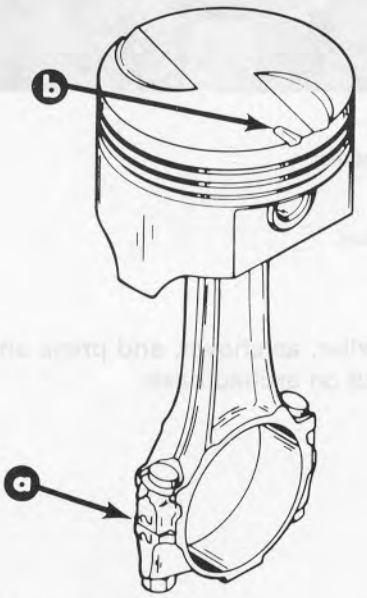
   c. With a thicker piston pin.

19421

IMPORTANT: Pistons must not be used in 180/190/ 3.7LX engines.

INSTALLATION

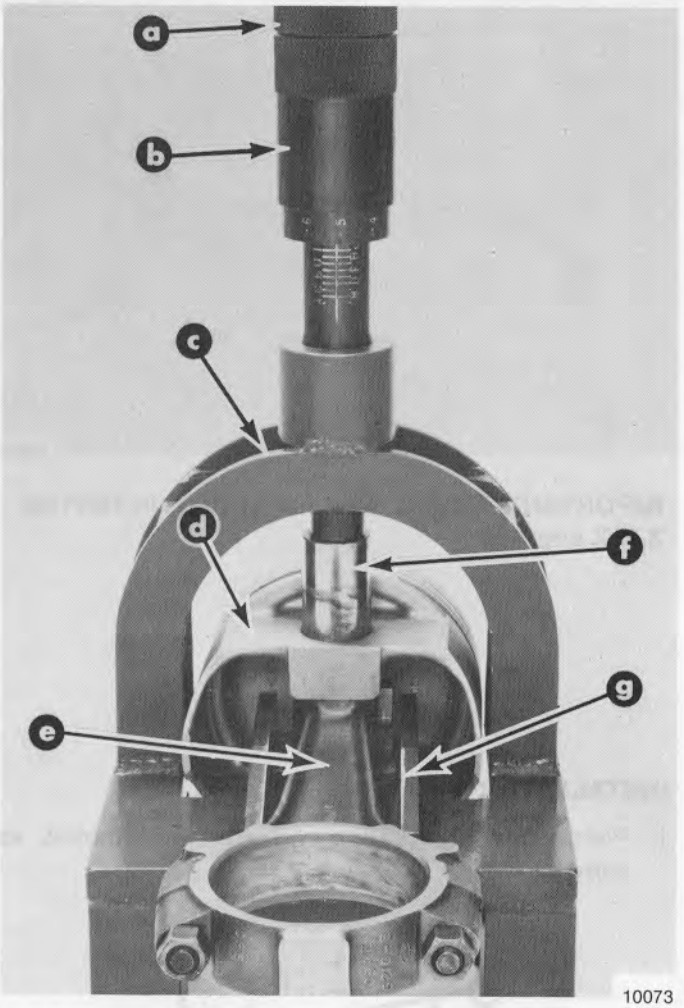
1. Piston and connecting rod are reassembled, as shown.



17647

a - Numbers TOWARD Camshaft
b - Pistons with Notch - Toward FRONT of Engine
Pistons without Notch - Can Be Installed Either Way on Connecting Rod

2. Lubricate piston pin, pin hole in piston and in rod end with engine oil.
3. Position rod and piston, as shown. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston.
4. Adjust installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.



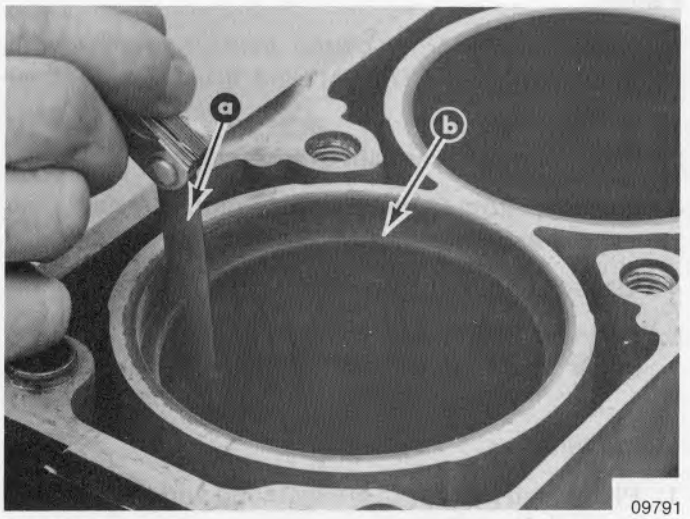
10073

a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

5. Insert installer, as shown, and press until installer bottoms out on arched base.

PISTON RINGS

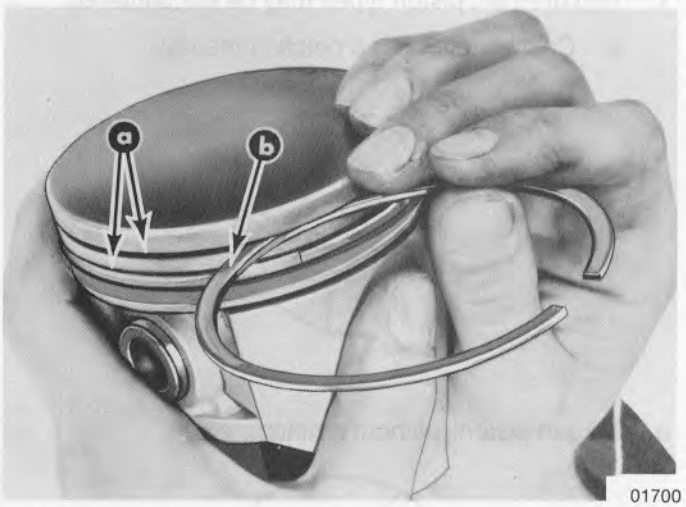
1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore squarely about 1/4" (6mm) from top.
3. Measure gap between ends of ring with feeler gauge. If gap is below specification, remove ring and try another.



09791

a - Feeler Gauge
b - Compression Ring

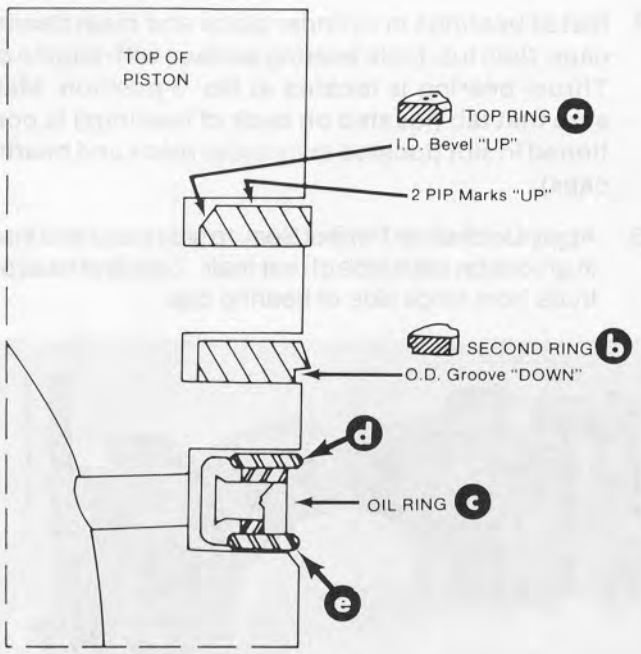
4. Clean, inspect and fit piston to cylinder.
5. Insert outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around groove to make sure that ring fit is free. If binding occurs at any point, determine the cause and correct.



01700

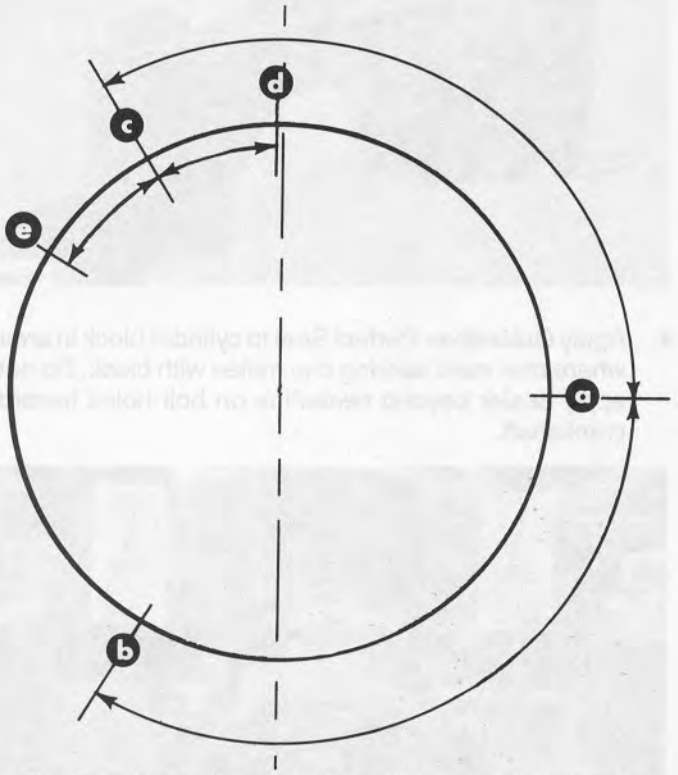
a - Piston Ring Groove (Top and Second)
b - Piston Ring

6. Refer to the following figures for piston ring installation.



a - Top Ring
b - Second Ring
c - Oil Expander Ring
d - Top Oil Ring Rail
e - Lower Oil Ring Rail

Piston Ring Identification



a - Top Compression Ring Gap (Toward Camshaft Side of Piston)
b - Second Compression Ring Gap (120° from Top Compression Ring Gap)
c - Oil Expander Ring Gap (120° from Top Compression Ring Gap)
d - Top Oil Ring Rail Gap [Approximately 1" (25mm)]
e - Lower Oil Ring Rail Gap [Approximately 1" (25mm)]

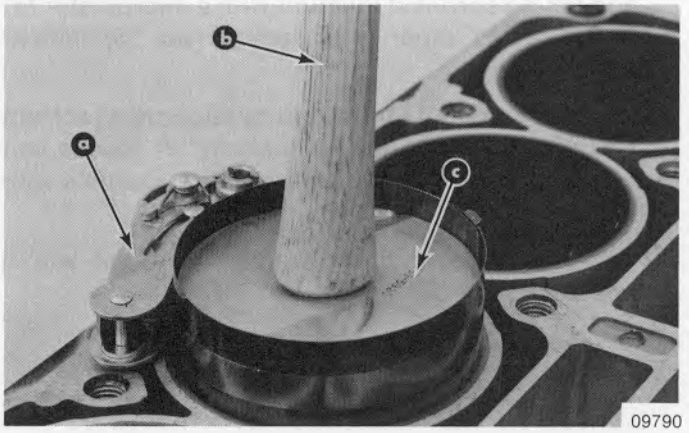
Piston Rings Gap Location

7. Measure clearances between compression ring and groove. (See "Specifications".) If ring cannot be fitted, piston must be replaced.

PISTON and ROD ASSEMBLY INSTALLATION

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinders from which they were removed.

1. Clean cylinder bores, as necessary. After cleaning, swab bores several times with light engine oil and clean cloth.
2. Install fitted connecting rod bearings in rods and rod caps. Lubricate rod bearings with engine oil.
3. Coat pistons, rings and cylinder walls with engine oil.
4. Install Tool (J-5239) on connecting rod bolts.
5. Install connecting rod and piston assembly in respective bore (number side of rod facing camshaft). Compress rings with Ring Compressor and install piston into bore. Hold ring compressor firmly against block until all piston rings have entered cylinder bore.



a - Ring Compressor
b - Hammer Handle
c - Piston

6. Remove guide tool from rod bolts.
7. Install bearing caps and torque nuts to specifications.

Crankshaft

REMOVAL

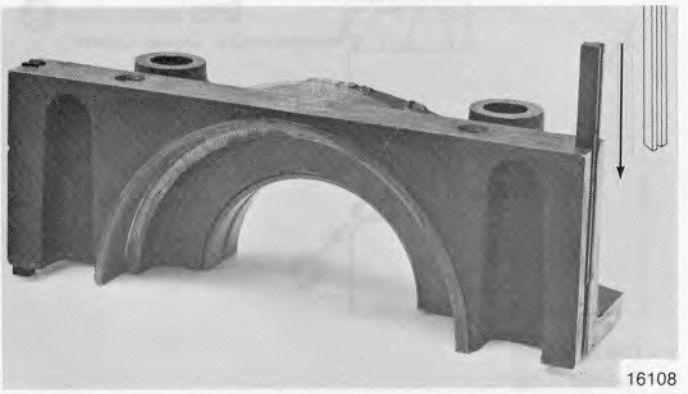
1. Remove flywheel housing, coupler and flywheel.
2. Remove spark plugs.
3. Remove oil pan and oil pump.
4. Remove front cover and timing chain.
5. Check connecting rod caps for cylinder number identification. If necessary, mark caps.
6. Remove connecting rod caps and push pistons to top of cylinders.
7. Remove main bearing caps and rear main oil seal and lift crankshaft out of cylinder block.
8. Remove main bearings from cylinder block and main bearing caps.

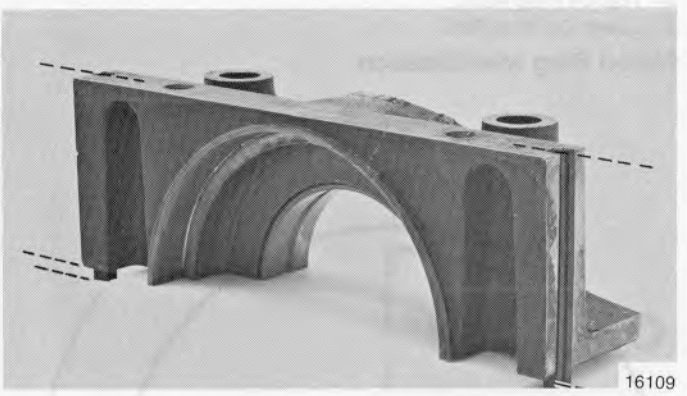
CLEANING and INSPECTION

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of all journals, oil seal area and timing sprocket location with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for run-out by supporting at front and rear main bearing journals in "V" blocks and check at front and rear intermediate journals with a dial indicator.
4. Replace or recondition crankshaft if not within specifications.

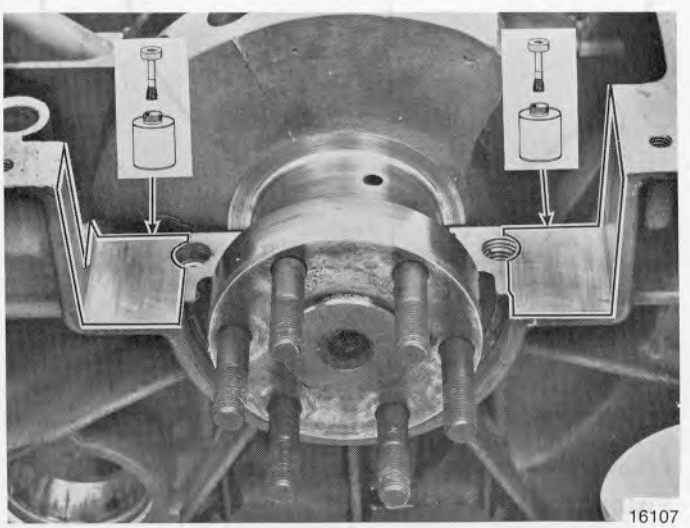
INSTALLATION

1. Check bearing clearance.
2. Install bearings in cylinder block and main bearing caps, then lubricate bearing surface with engine oil. Thrust bearing is located at No. 3 position. Make sure that tab (located on back of bearings) is positioned in slot (located in cylinder block and bearing caps).
3. Apply Quicksilver Perfect Seal, to side seals and install in groove on each side of rear main. Seal end must protrude from block side of bearing cap.

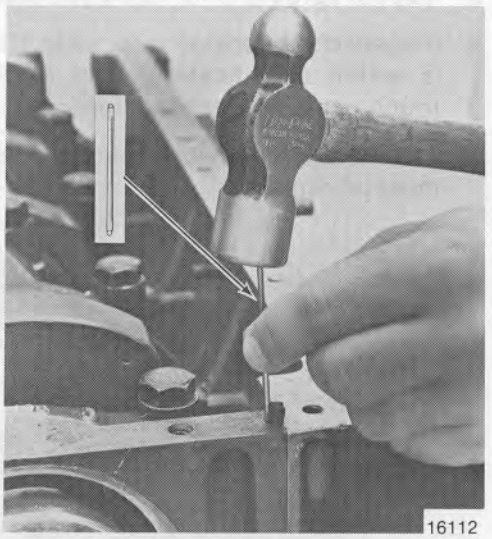

16108


16109

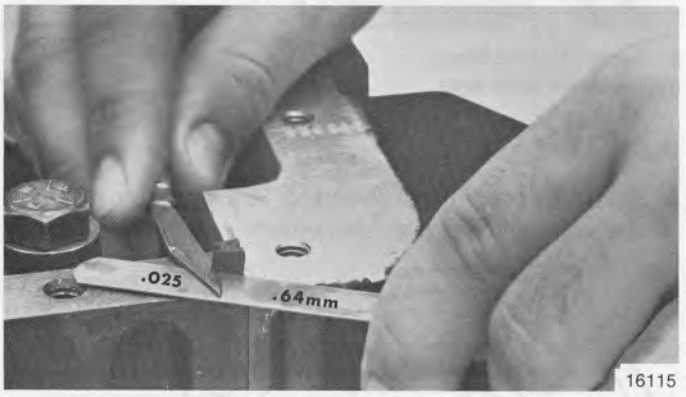
4. Apply Quicksilver Perfect Seal to cylinder block in area where rear main bearing cap mates with block. Do not apply sealer beyond centerline on bolt holes toward crankshaft.


16107

5. Apply Quicksilver Perfect Seal to outside face of side seals on rear cap to facilitate installation and install rear cap.
6. Install cap bolts, but do not torque.
7. Install pins until they are flush with top of cap.

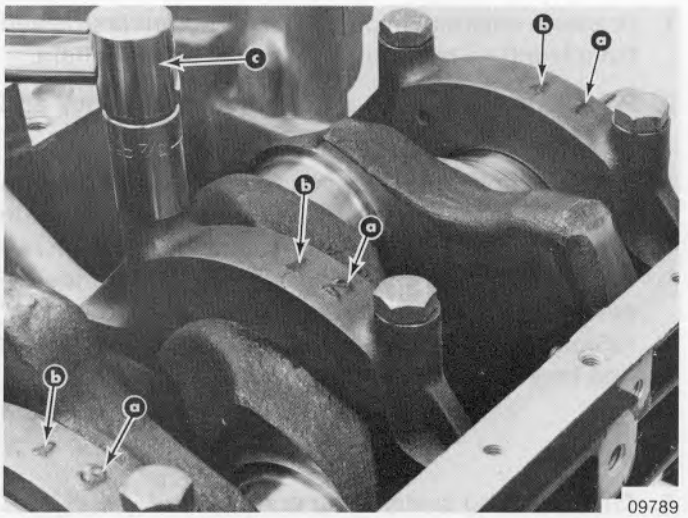

16112

8. Torque rear main bearing cap bolts to specifications.
9. Using feeler gauge as guide, cut each side seal to extend out of cap, as shown.



16115

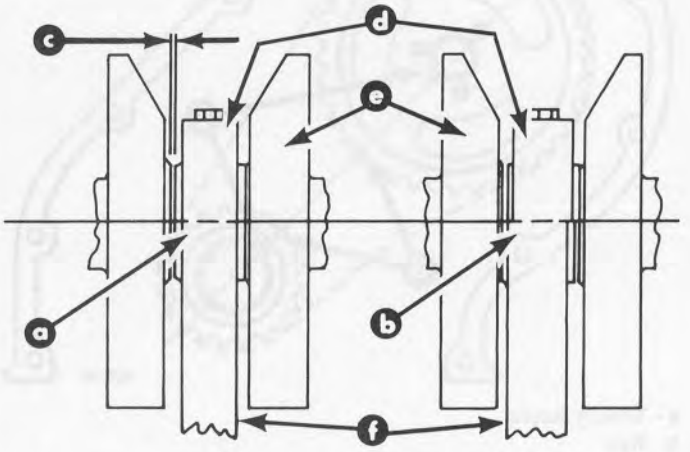
10. Install 4 other bearing caps with cast arrow pointing toward front of engine and cast numbers in their respective location. Torque all bearing cap bolts (except No. 3) to specifications.



09789

a - Cast Numbers
b - Cast Arrows
c - Torque Wrench

11. To prevent misalignment of thrust bearing (located at No. 3 bearing cap), pry crankshaft toward front of engine, then toward rear of engine. With crank in this position, torque bolts to specifications. Correct bearing alignment is shown.



a - Correct Alignment
b - Incorrect Alignment
c - Crankshaft End Play
d - Bearing Cap
e - Crankshaft
f - Cylinder Block

12. Check crankshaft end play with feeler gauge between thrust bearing and crankshaft.
13. Check that crankshaft turns freely with little effort. If crank does not turn freely, bearing clearances, bearing and journal diameters and crank straightness should be checked.
14. Reinstall connecting rods.
15. Install front cover, oil pump, oil pan, spark plugs, flywheel, coupler and flywheel housing.

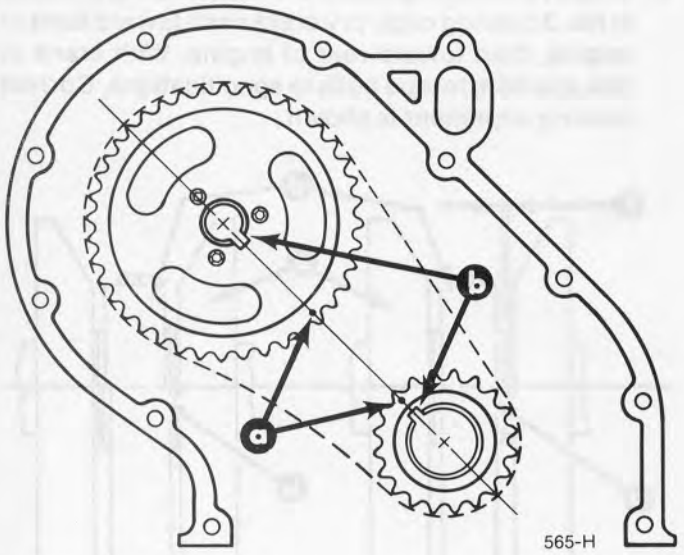
Crankshaft/Camshaft Sprockets and Timing Chain

CHECKING TIMING CHAIN DEFLECTION

1. Rotate crankshaft in clockwise direction (as viewed from front) to take up slack on left side of chain.
2. Establish a reference point on cylinder block and measure from this point to chain.
3. Rotate crankshaft in opposite direction to take up slack on right side of chain. Force left side of chain out with fingers and measure distance between reference point and chain. Deflection is difference between the 2 measurements. If deflection exceeds 1" (25mm), replace timing chain and inspect sprockets and tensioner for abnormal wear.

REMOVAL

1. Drain cooling system and crankcase.
2. Remove alternator rotor, stator and front cover.
3. Crank engine until timing marks on sprockets are positioned as shown.

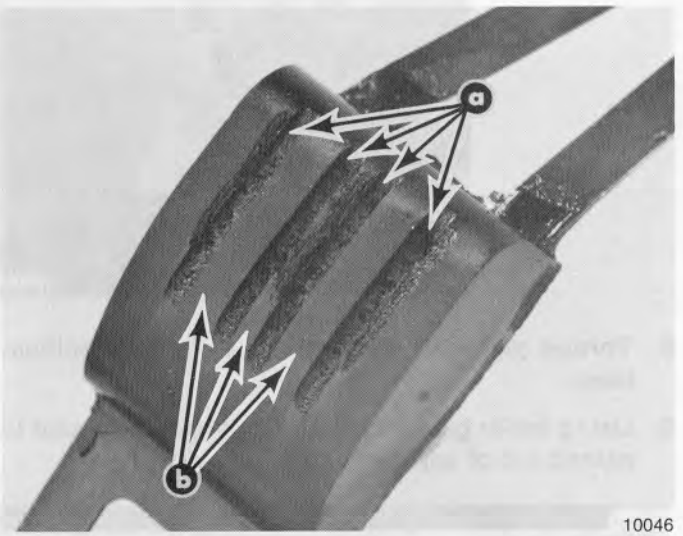


a - Timing Marks
b - Key

4. Remove chain tensioner and camshaft sprocket attaching screws.
5. Slide both sprockets and timing chain forward and remove as an assembly.

CLEANING and INSPECTION

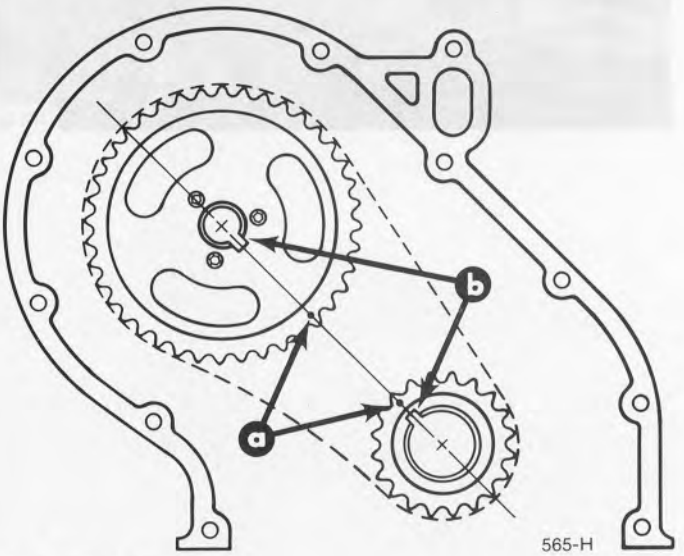
1. Clean all parts in solvent and dry with compressed air.
2. Inspect chain.
3. Inspect sprockets for damaged teeth.
4. Inspect chain tensioner for wear. If chain deflection is within specifications and tensioner does not touch chain, replace tensioner.
5. Tensioner, that is worn beyond normal groove wear must be replaced.



a - Normal Groove Wear
b - Excessive Wear Area

INSTALLATION

1. Position crankshaft locating key and camshaft locating key facing, as shown.



a - Timing Marks
b - Key

2. Place timing chain around sprockets and simultaneously install sprockets (with chain) on camshaft and crankshaft. Timing marks must be located as shown. Check timing mark location, using a straight edge.
3. Install camshaft fastening screws and torque to specifications.
4. Install chain tensioner. Liberally lubricate chain, chain tensioner and sprockets with engine oil.
5. Install front cover, stator and alternator rotor.
6. Fill cooling system and crankcase to proper levels.

Camshaft

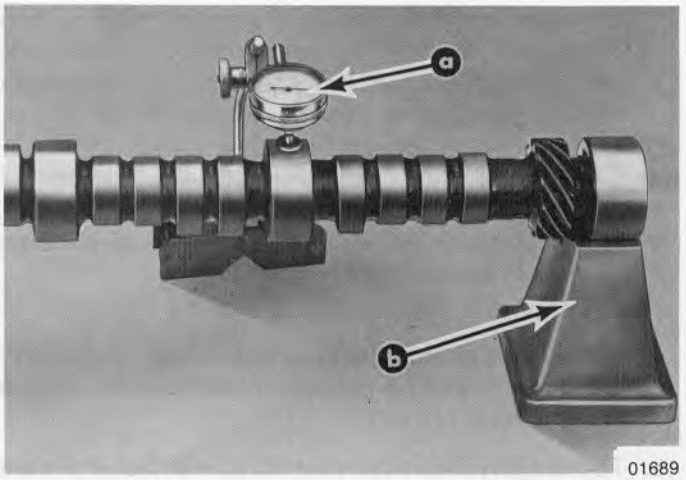
REMOVAL

1. Remove valve lifters.
2. Remove front cover.
3. Remove fuel pump.
4. Align timing gear marks, then remove timing chain and sprockets.
5. Pull camshaft out thru front of block.

IMPORTANT: Support camshaft carefully when removing to protect camshaft bearing surface.

INSPECTION

1. Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed specifications, replace camshaft.
2. Check camshaft for alignment with "V" blocks and dial indicator for amount out-of-true. If out more than .002" (.051mm), replace camshaft.



a - Dial Indicator
b - "V" Blocks

3. Inspect camshaft sprocket and thrust plate for wear or damage.
4. Check all camshaft lobes with dial indicator. If not within specifications, replace camshaft.

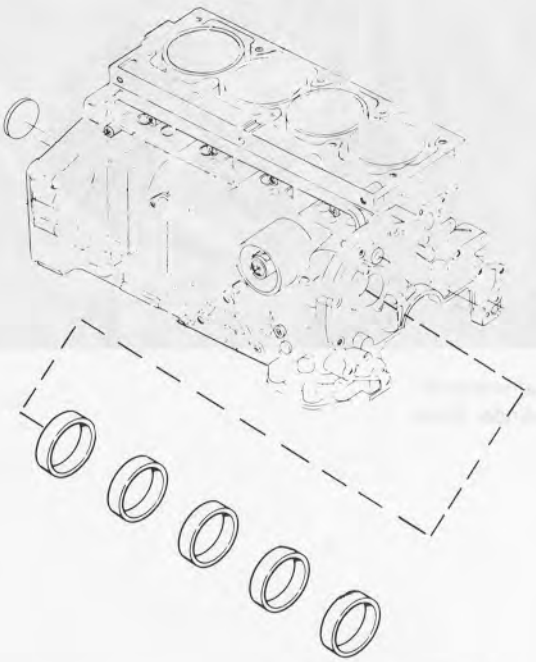
INSTALLATION

1. Install camshaft in engine block, being careful not to damage camshaft bearing surface or camshaft. Install thrust plate and torque screws to specifications.
2. Install timing chain and sprockets. Torque screws to specifications.
3. With sprockets and timing chain properly installed, check camshaft end play. Use dial indicator on face of camshaft sprocket and move camshaft in-and-out while recording end play. If not within specifications, replace thrust plate and/or sprocket.
4. Install fuel pump.
5. Install engine front cover.
6. Install valve lifters.

Camshaft Bearings

Camshaft rotates directly in aluminum (cylinder block) bores. If bore surface is damaged, bore can be line bored 2.2495" to 2.2510" (57.137mm to 57.175mm) diameter and bearings can be installed. Refer to Parts Manual for bearings. If one bore surface is damaged, all bores should be enlarged and bearings installed. Tool Kit T65L-6250-A should be used. Oil hole in bearing must align with oil hole in block. Follow tool manufacturer's installation instructions.

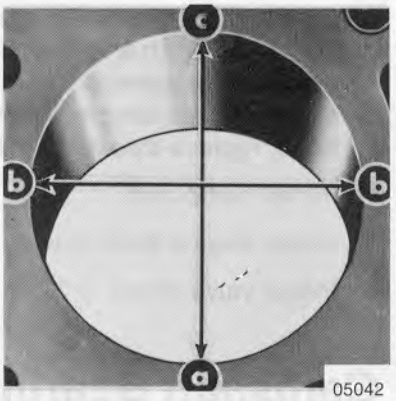
After bearings are installed, I.D. of bearings must be line bored to 2.1258"-2.1268" (53.995-54.020mm).



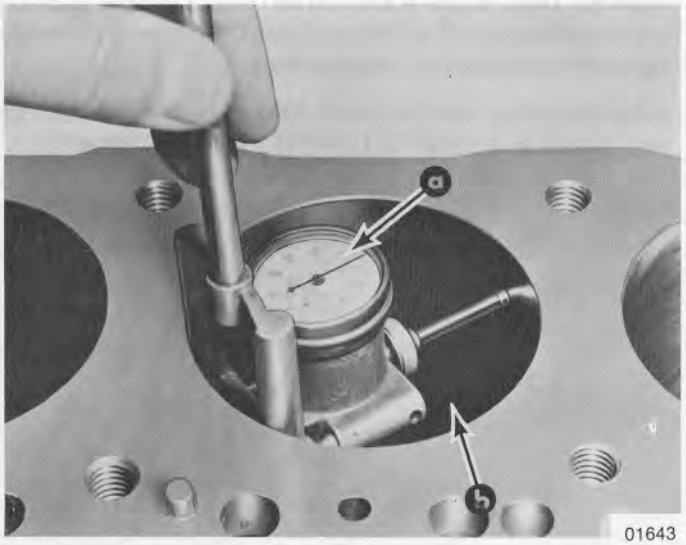
Cylinder Block

CLEANING and INSPECTION

1. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
2. Remove oil galley plugs and clean all oil passages.
3. Inspect cylinder block (see "Specifications").
4. Measure the cylinder walls with dial indicator for taper, out-of-round or excessive ridge at top of ring travel. If cylinders exceed specifications, honing and/or boring are necessary.



a - At Right Angle to Centerline of Engine
b - Parallel to Centerline of Engine
Taper - Difference between "a" Measurement at Top of Cylinder Bore and "a" Measurement at Bottom of Cylinder Bore
Out-of-Round - Difference between "a" and "b"
c - Centerline of Engine



a - Dial Indicator
b - Cylinder Bore

REPAIRS

Cylinder Conditioning

If cylinders have less than .005" (0.127mm) taper or wear, condition them with a hone and fit with high limit, standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. If such is the case, clean up bore entirely by reboring for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that permits complete resurfacing of all cylinders.

When pistons are fitted (honing not necessary), clean cylinder bores with detergent and hot water. After cleaning, swab cylinder bores several times with light engine oil on clean cloth, then wipe with clean, dry cloth.

Cylinder Boring

1. Before using any type boring bar, clean top of cylinder block to remove dirt or burrs.
2. Measure piston to be fitted with a micrometer. Bore cylinder to same diameter as piston and hone cylinder to specifications and as outlined under "Cylinder Honing" and "Piston Selection".
3. Follow instructions furnished by manufacturer of equipment being used.

Cylinder Honing

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up-and-down to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp and free from imbedded particles and torn or folded metal.

⚠CAUTION
Handle pistons with care and do not attempt to force them thru cylinder, as this type piston can be distorted thru careless handling.

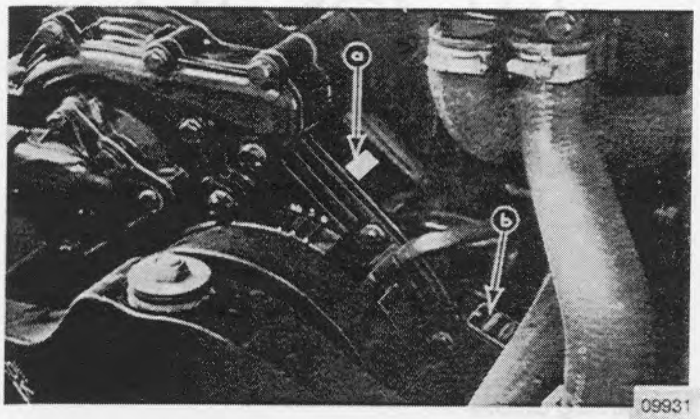
4. Permanently mark piston for cylinder to which it has been fitted and proceed to hone cylinders and fit remaining pistons.
5. Thoroughly clean cylinder bores with hot water and detergent. Rinse thoroughly with hot water.
6. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean, dry cloth. Do not clean cylinder with kerosene or gasoline.

Piston Selection

⚠CAUTION

Piston with locating notch on top must not be installed with other pistons. Engine must use either 4 notched or 4 pistons without the notch.

When the cylinder bore is enlarged, oversize pistons are installed in all cylinders. .0___" is stamped on cylinder block in area shown.



a - Identification Mark Location
b - Serial Plate

1. Check used piston to cylinder bore clearance as follows:
   a. Measure "Cylinder Bore Diameter" with a telescope gauge.
   b. Measure "Piston Diameter" at location shown.
   c. Subtract piston diameter from cylinder bore diameter to determine "Piston to Bore Clearance".
   d. Determine if piston to bore clearance is in acceptable range.
2. If used piston is not acceptable, check oversize pistons available. Refer to Parts Manual.
3. If cylinder bore must be reconditioned, measure new piston diameter, then hone cylinder bore to correct clearance.
4. Mark piston to identify cylinder for which it was fitted.

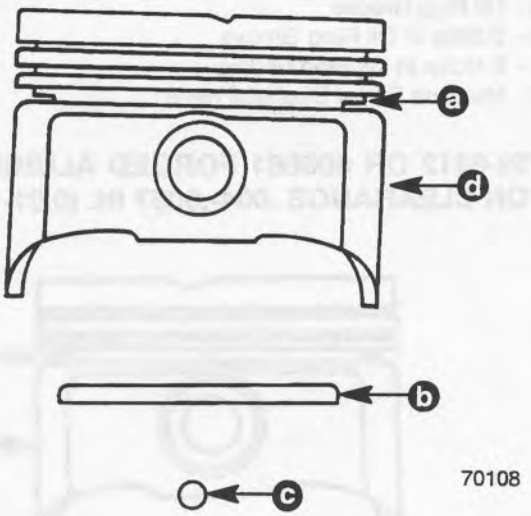
224 CID (3.7L) PISTON IDENTIFICATION, TYPE AND CLEARANCE

IMPORTANT: There are four different forged pistons. Numbers will be stamped on top or inside skirt of the piston (759-5920, 759-6610, 759-8312 806661). These numbers can be intermixed in an engine. These pistons cannot be mixed with cast pistons.

⚠CAUTION

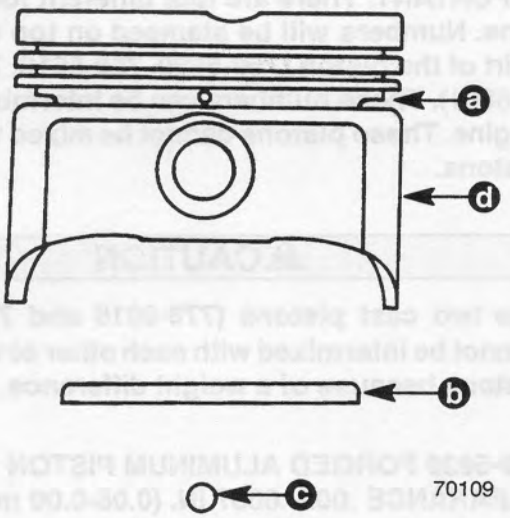
The two cast pistons (778-9015 and 778-9441) cannot be intermixed with each other or with cast pistons because of a weight difference.

759-5920 FORGED ALUMINUM PISTON CLEARANCE .002-.0037 IN. (0.05-0.09 mm)



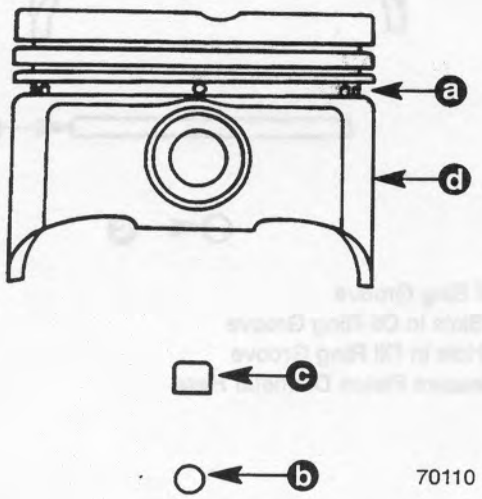
a - Oil Ring Groove
b - 2 Slots In Oil Ring Groove
c - 1 Hole In Oil Ring Groove
d - Measure Piston Diameter Here

759-6610 FORGED ALUMINUM PISTON CLEARANCE .002-.0037 IN. (0.05-0.09 mm)



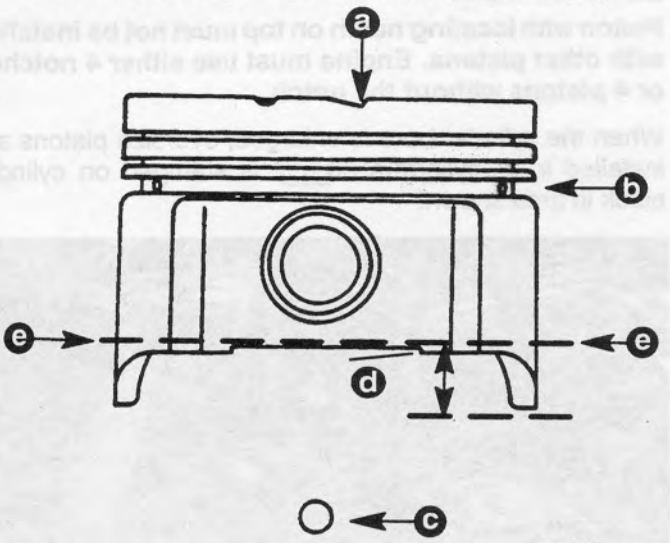
a - Oil Ring Groove
b - 2 Slots In Oil Ring Groove
c - 2 Holes In Oil Ring Groove
d - Measure Piston Diameter Here

759-8312 OR 806661 FORGED ALUMINUM PISTON CLEARANCE .004-.0057 IN. (0.01-1.5 mm)



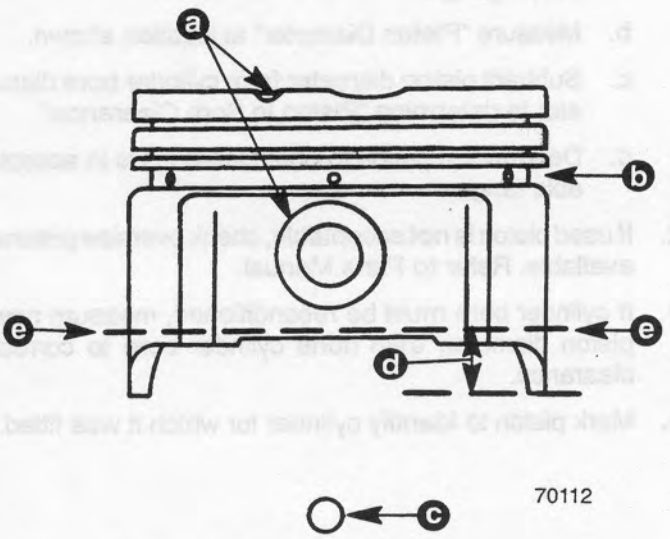
a - Oil Ring Groove
b - 2 Holes In Oil Ring Groove
c - 8 Square Holes In Oil Ring Groove
d - Measure Piston Diameter Here

778-9015 CAST ALUMINUM PISTON CLEARANCE .001-.0027 IN. (0.03-0.06 mm)

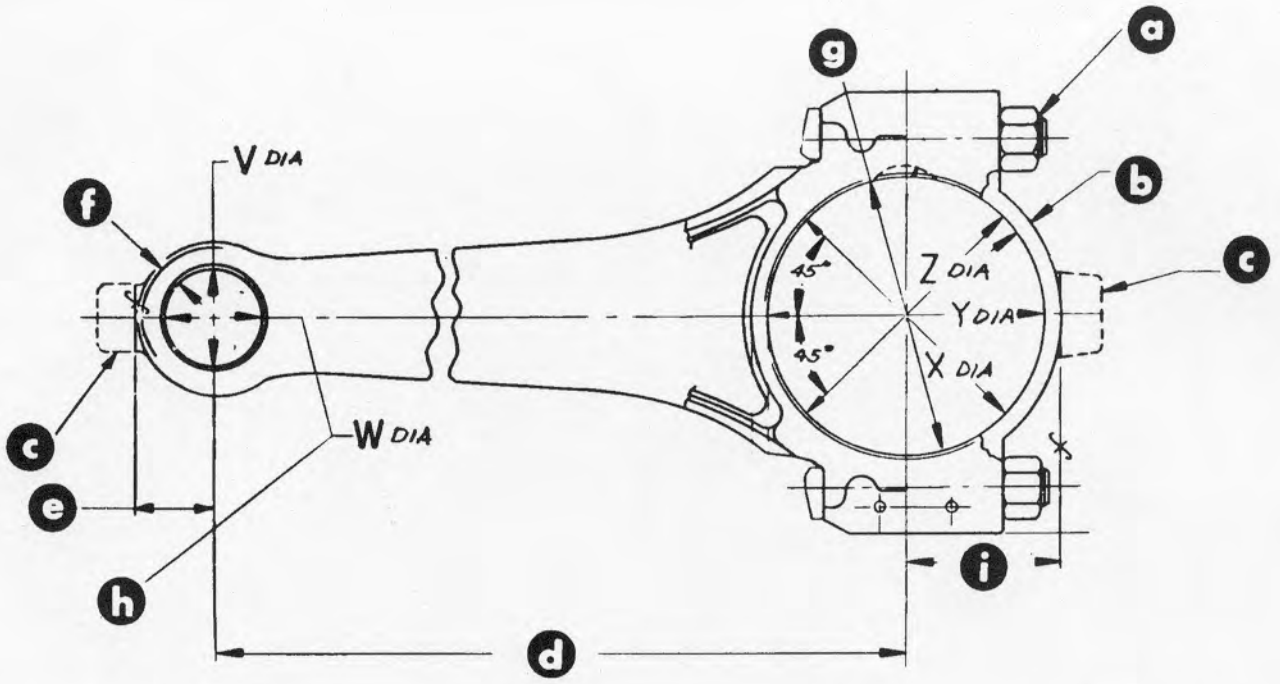


a - Notch
b - Oil Ring Groove
c - 4 Holes In Oil Ring Groove
d - 13/16 In. (20 mm) From Bottom Of Piston
e - Measure Piston Diameter Here

778-9441 CAST ALUMINUM PISTON CLEARANCE .001-.0027 IN. (0.03-0.06 mm)



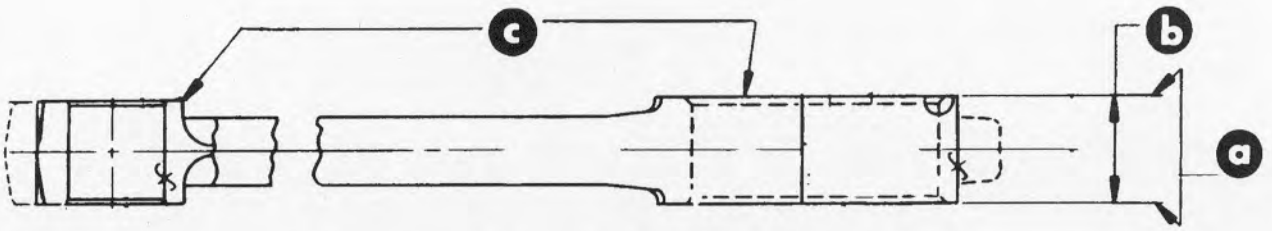
a - Larger Notch and Thicker Wrist Pin
b - Oil Ring Groove
c - 6 Holes In Oil Ring Groove
d - 13/16 in. (20 mm) From Bottom Of Piston
e - Measure Piston Diameter Here



a - Torque to 40-45 lbs. ft. (54-61 N·m)
b - .155" (3.937 mm) Min. Both Sides
c - Remove Metal from this Boss to Maintain Weight
d - 6.6035"-6.6065" (167.7289-167.8051 mm)
e - .700" (17.780 mm) Min.
f - .100" (2.540 mm) Min. Both SIdes
g - Production: 2.6522"-2.6530" (67.3658-67.3862 mm); [Service: 2.6522"-2.6540" (67.3658-67.5116 mm)] - Minor Diameter in Plane of Web in as Machined COndition. Measure at X-Y or Z. Major Diameter May Exceed Limits by Amount Following. Diameter Measurements Not to Vary in Excess of Production: .003" (.0762 mm) [Service: .005" (.127 mm)] Between "X" and "Y" (Octant Angle) or Between "Y" and "Z" (Octant Angle) or .0004" (.01016 mm) Between "X" and "Z" (Quadrant Angle Including Above Angles) Diametral Deviation (Barrel Shape - Hour Glass or Taper) When Measured in Plane thru "Y" Containing the Axis Not to Exceed .0006" (.01524 mm) per Inch (25 mm) Between Any Two Measuring Points and .004" (.01016 mm) per Inch in Length of Journal
h - Diameter at "W" - Production: 1.0386"-1.0393" (26.38044-26.39822 mm); [Service: 1.0386"-1.0395" (26.38044-26.40330 mm)] Piston Pin Hole Size to be Measured in Plane of Web. Out of Round When Measured in Plane of Web - Diametral Dimension "V" to be .0001" (.00254 mm) Greater to .0004" (.01016 mm) Smaller than Diametral Dimension "W". Diametral Deviation (Barrel Shape - Hour Glass or Taper) When Measured in Plane thru "W" Containing the Axis Must Not Exceed .0015" (.0381 mm) per Inch (25 mm) and Not to Exceed .001" (.0254 mm) Total
i - 1.550" (39.37 mm)

FINISHED WEIGHT OF ASSEMBLED ROD	
COMPLETE ROD	779-791 GRAMS
PISTON PIN END	204-210 GRAMS
CRANKSHAFT END	575-581 GRAMS

Figure 1. Connecting Rod

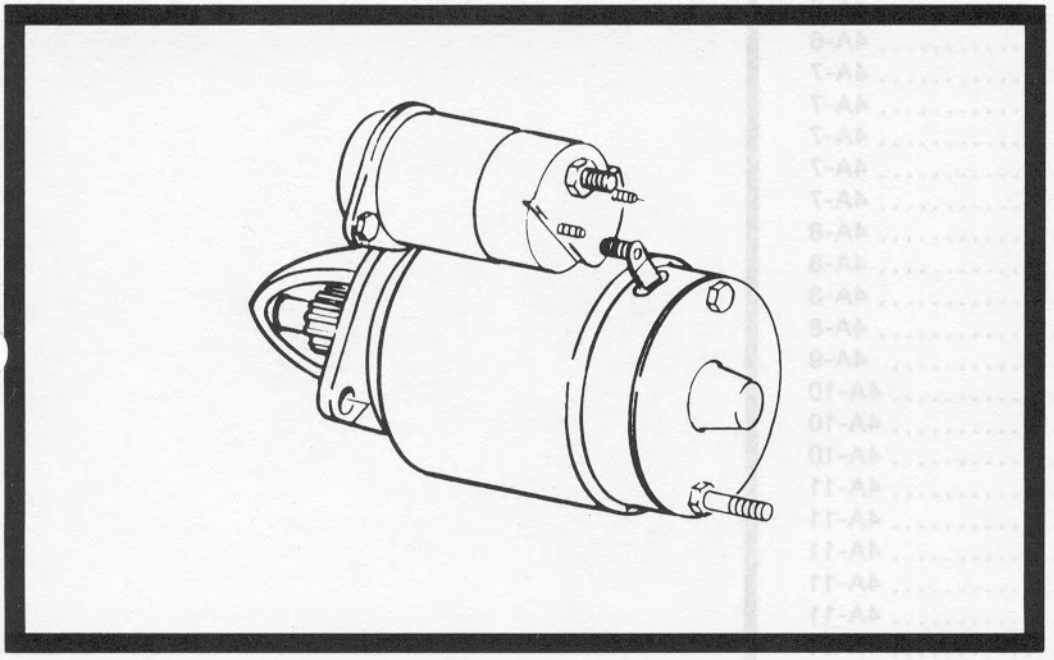


a - Runout of These Surfaces Must Be Within .0025" (.0635 mm) Total Indicator Runout In Relation to Crankpin Bore
b - .9985"-1.0015" (25.3619-25.4381 mm)
c - These Surfaces Must Be In a True Plane Within .010" (.254 mm) Total Indicator Runout

Figure 2. Connecting Rod

FINISHED WEIGHT OF ASSEMBLED ROD	
COMPLETE ROD	279-291 GRAMS
PISTON PIN END	204-210 GRAMS
CRANKSHAFT END	575-581 GRAMS

ELECTRICAL SYSTEMS



4

A

STARTING SYSTEM

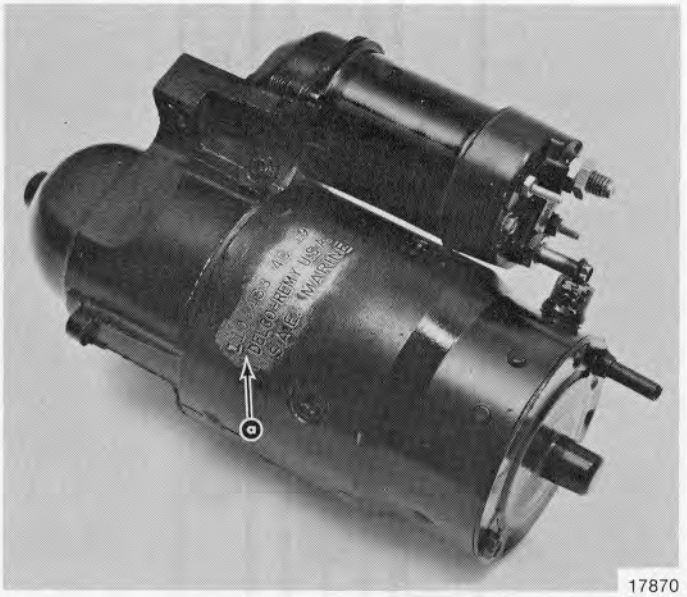
mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Identification	4A-1
Replacement Parts Warning	4A-1
Battery	4A-1
Battery Cable Recommendation	4A-1
Maintenance	4A-1
Testing	4A-2
Storage	4A-2
Battery Power as Affected by Temperature	4A-2
Charging Guide	4A-3
Slave Solenoids	4A-3
Types	4A-3
Testing	4A-4
Delco-Remy Starter Motor Specifications	4A-5
Torque Specifications	4A-5
Lubricants-Sealants	4A-5
Starting System Components	4A-6
Starter Motor Assembly	4A-7
Notice	4A-7
Periodic Inspection	4A-7
Repair	4A-7
Removal	4A-7
Solenoid Switch	4A-8
Removal	4A-8
Replacement of Contacts	4A-8
Installation	4A-8
Starter Motor Disassembly	4A-9
Cleaning and Inspection	4A-10
Armature Tests	4A-10
Test for Shorts	4A-10
Test for Ground	4A-11
Field Coil Tests	4A-11
Test for Open Circuit	4A-11
Test for Ground	4A-11
Loose Electrical Connections	4A-11
Turning the Commutator	4A-11
Reassembly	4A-12
Clearances	4A-13
Pinion Clearance	4A-13
Commutator End Frame Gap	4A-14
Installation	4A-14

Identification

The starter identification number is located as shown.



17870

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Battery

IMPORTANT: Terminals MUST BE soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder ONLY. DO NOT use acid flux solder, as it may cause corrosion and failure.

BATTERY CABLE

Cable Length	Cable Gauge
Up to 3-1/2 Ft. (1.1m)	4 (19mm²)
3-1/2 - 6 Ft. (1.1-1.8m)	2 (32mm²)
6 - 7-1/2 Ft. (1.8-2.3m)	1 (40mm²)
7-1/2 - 9-1/2 Ft. (2.3-2.9m)	0 (50mm²)
9-1/2 - 12 Ft. (2.9-3.7m)	00 (62mm²)
12 - 15 Ft. (3.7-4.6m)	000 (81mm²)
15 - 19 Ft. (4.6-5.8m)	0000 (103mm²)
Both positive (+) and negative (-) cables	

Maintenance

⚠WARNING

Hydrogen gases that escape from the battery during charging are explosive. Be sure that battery area is well ventilated and that bilge blower is in operation when charging. DO NOT smoke or allow sources of spark or open flame in area when charging battery.

⚠WARNING

Battery electrolyte is a corrosive acid and should be handled with extreme care. If electrolyte is spilled or splashed on any part of the body, IMMEDIATELY flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible. Safety glasses and rubber gloves are recommended when handling batteries.

⚠CAUTION

To prevent damage to the electrical system be sure to adhere to the following:

a. **When installing battery, be sure to connect the (-) negative (grounded) battery cable to the (-) negative battery terminal and (+) positive battery cable to (+) positive battery terminal.**

b. **Never disconnect the battery cables while the engine is running.**

c. **If a charger or booster is to be used, BE SURE to connect it in parallel with existing battery (positive to positive and negative to negative).**

d. **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**

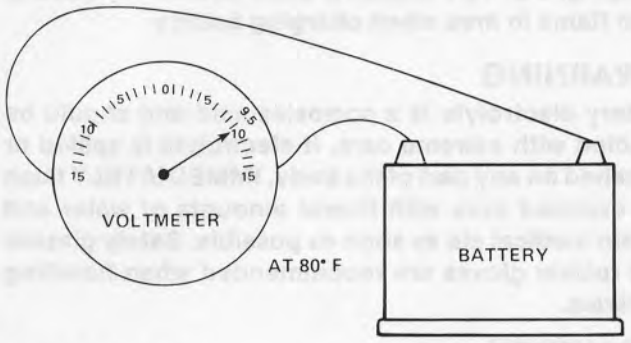
e. **Check battery condition periodically.**

f. **Make sure that battery leads are kept clean and tight.**

TESTING

Load Test

A strong battery must be maintained. If battery shows less than 9-1/2 volts when under starting load, it should be recharged. Check with DC voltmeter.



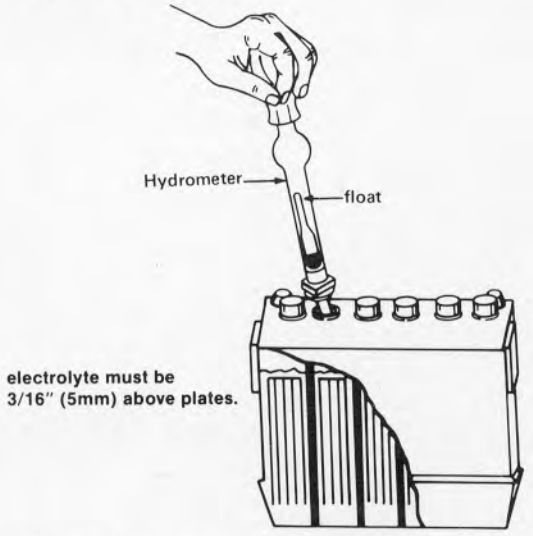
⚠WARNING

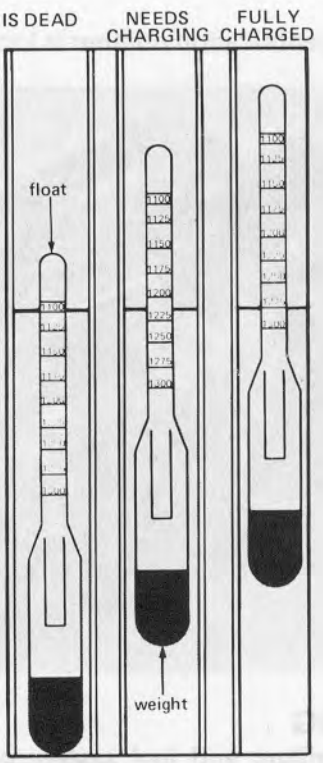
Test battery in well ventilated area as gases given off by battery are hazardous.

Hydrometer Test

When using a hydrometer, observe the following points:

1. Hydrometer must be clean (inside and out) to insure an accurate reading.
2. Never take hydrometer readings immediately after water has been added.
3. If hydrometer has built-in thermometer, draw liquid in several times to ensure correct temperature before taking reading.
4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free-floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid.
5. Avoid dropping electrolyte on boat or clothing, as it is extremely corrosive. Wash off immediately with baking soda solution.





It is the activity of the acid (hyd. reading) which determines the activity of that cell.

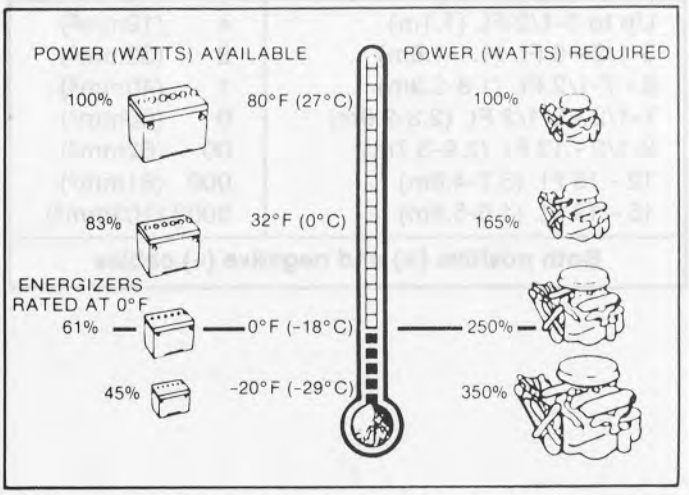
Fully Charged	1.280	1.260
75% Charged	1.230	1.220
50% Charged	1.180	1.170
25% Charged	1.130	1.120
Discharged	1.080	1.070

STORAGE

1. Remove battery and clean exterior.
2. Check fluid level and fill if low.
3. Cover terminals and bolts with light coat of grease.
4. Set battery on wood or in carton, store in cool, dry place.
5. Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

BATTERY POWER as AFFECTED by TEMPERATURE



CHARGING GUIDE

12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition

Twenty Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 Ampere-Hours or Less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/4 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

* Initial rate for constant voltage taper rate charger

To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125°F (52°C).
2. Violent gassing or spewing of electrolyte occurs.

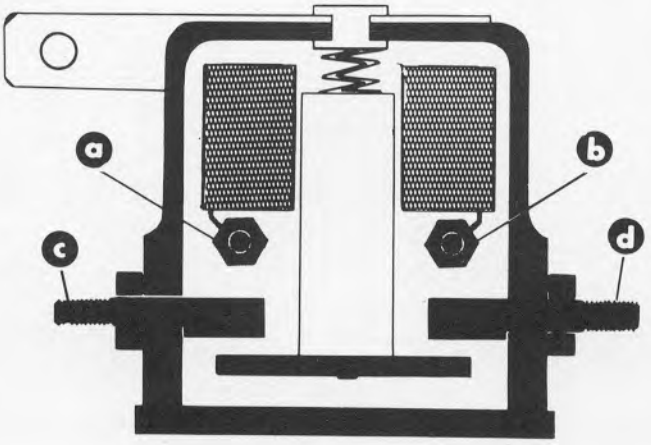
Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

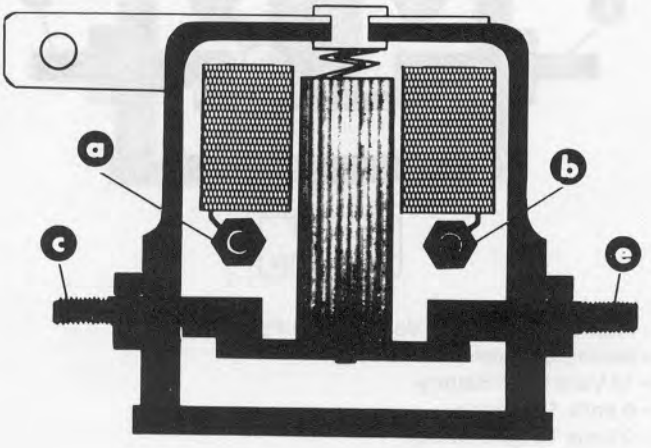
Slave Solenoids

TYPES

There are two ("standard" or "switch") types of slave solenoids used on MerCruiser engines. 170 and 190 engines (with Prestolite starter motors) use a "switch type" slave solenoid as a starter solenoid. The other engines use a slave solenoid to energize the starter motor solenoid. Some model engines use the small terminal on the "switch type" solenoid for ignition by-pass during the starting of the engine. Because of this, be sure to use correct type of slave solenoid for replacement.



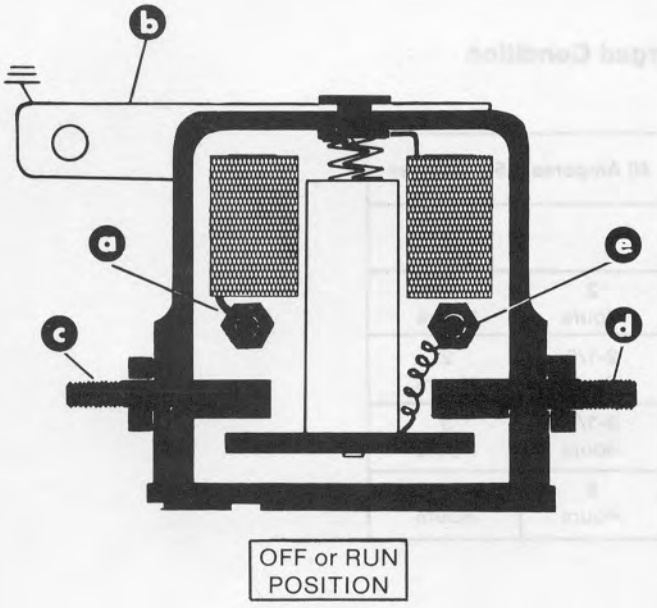
OFF or RUN POSITION

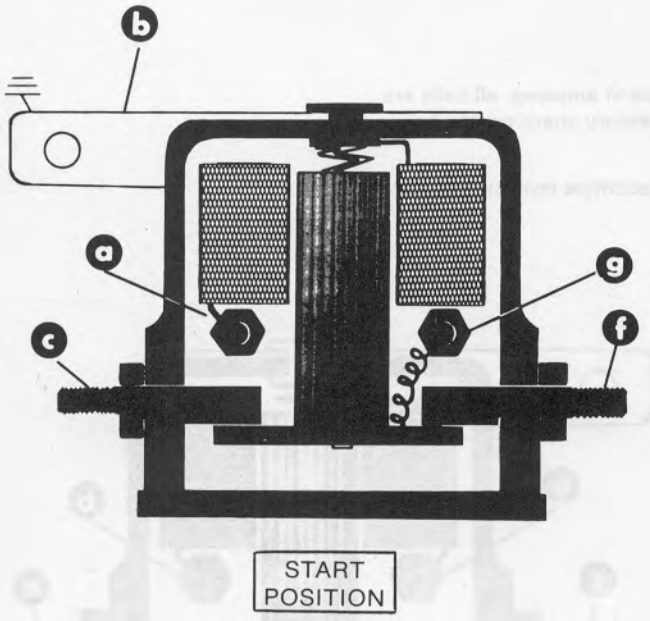


START POSITION

a - From Key Switch (12 Volts in Start Position)
b - To Ground
c - 12 Volts From Battery
d - 0 Volts To Starter
e - 12 Volts To Starter

"Standard Type" Slave Solenoid





a - From Key Switch (12 Volts in Start Position)
b - Mounting Bracket and Ground
c - 12 Volts From Battery
d - 0 Volts To Starter
e - 0 Volts To Ignition Coil
f - 12 Volts To Starter
g - 12 Volts To Ignition Coil

"Switch Type" Slave Solenoid

TESTING

1. Disconnect battery cables, then remove all wires from solenoid terminals.
2. Remove solenoid.
3. **Standard Type:**
   a. Connect continuity meter to large terminals.
   b. Connect jumper wire from positive (+) terminal on 12 volt battery to "a" terminal on solenoid.
   c. Connect jumper wire from negative (-) terminal of battery to "b" terminal on solenoid.
   d. If meter does not move, replace solenoid.

   Switch Type:
   a. Connect continuity meter to large terminals.
   b. Connect jumper wire from positive (+) terminal on 12 volt battery to "a" terminal on solenoid.
   c. Connect jumper wire from negative (-) terminal of battery to "b" mounting bracket.
   d. If meter does not move, replace solenoid.
   e. To test ignition by-pass, move meter lead from "f" terminal to "g" terminal. If meter does not move, replace solenoid.
4. Install solenoid.
5. Reconnect wires to terminals. Tighten securely and coat with Liquid Neoprene.
6. Reconnect battery cables. Tighten securely.

Delco-Remy Starter Motor Specifications

No Load Test						
Identification Number	**Volts**	**Min. Amps**	**Max. Amps**	**Min. RPM**	**Max. RPM**	**Brush Spring Tension**
50-4248541 (Delco-Remy) 1998460	10.6	60	100	5300	10,600	56 - 105 Oz. (1588 - 2976 g)
Pinion Clearance		.010" - .140" (.25 - 3.5mm)				
Commutor End Frame Gap		.025" (.6mm)				

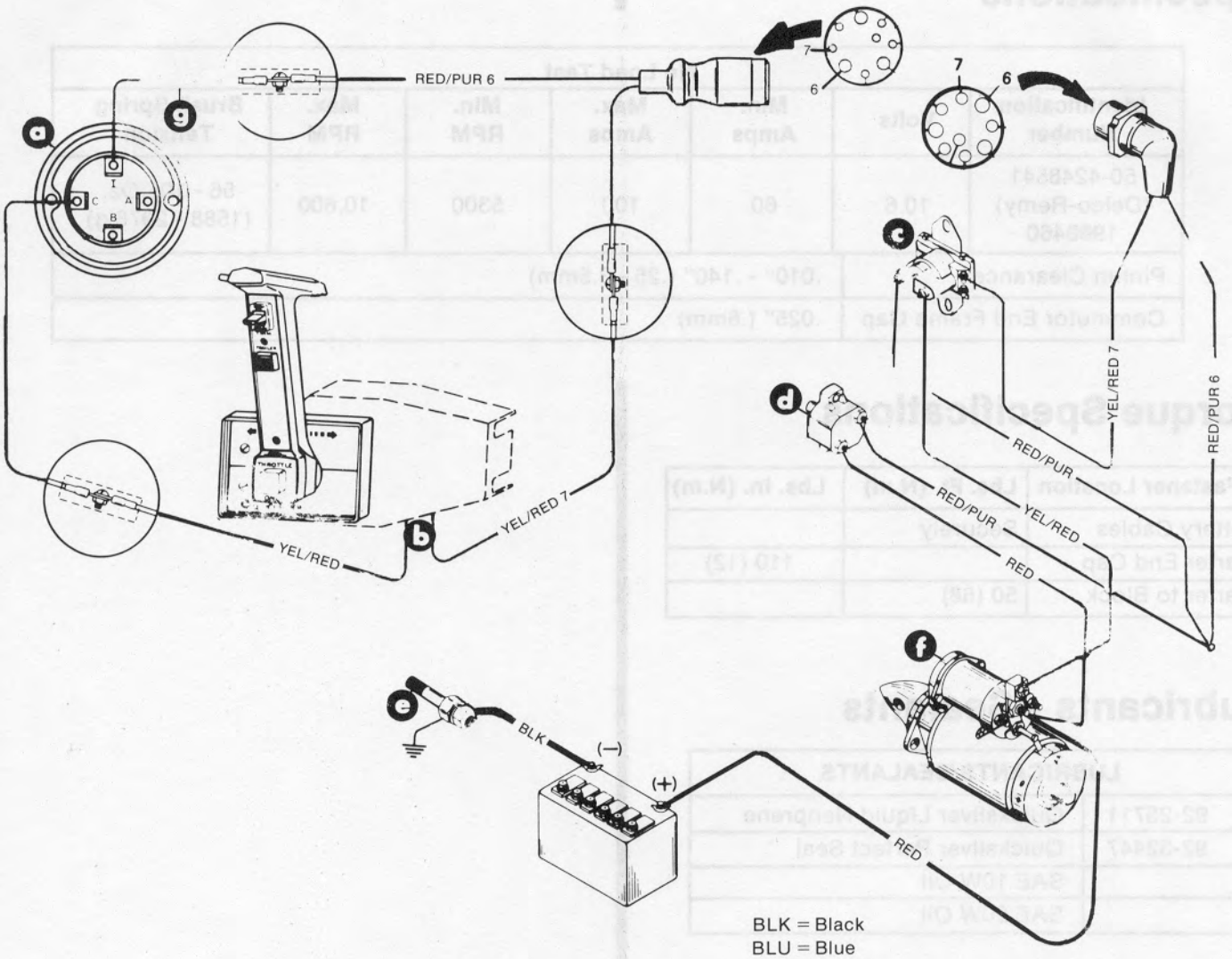
Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Starter End Cap		110 (12)
Starter to Block	50 (68)	

Lubricants - Sealants

LUBRICANTS/SEALANTS	
92-25711	Quicksilver Liquid Neoprene
92-32447	Quicksilver Perfect Seal
	SAE 10W Oil
	SAE 20W Oil

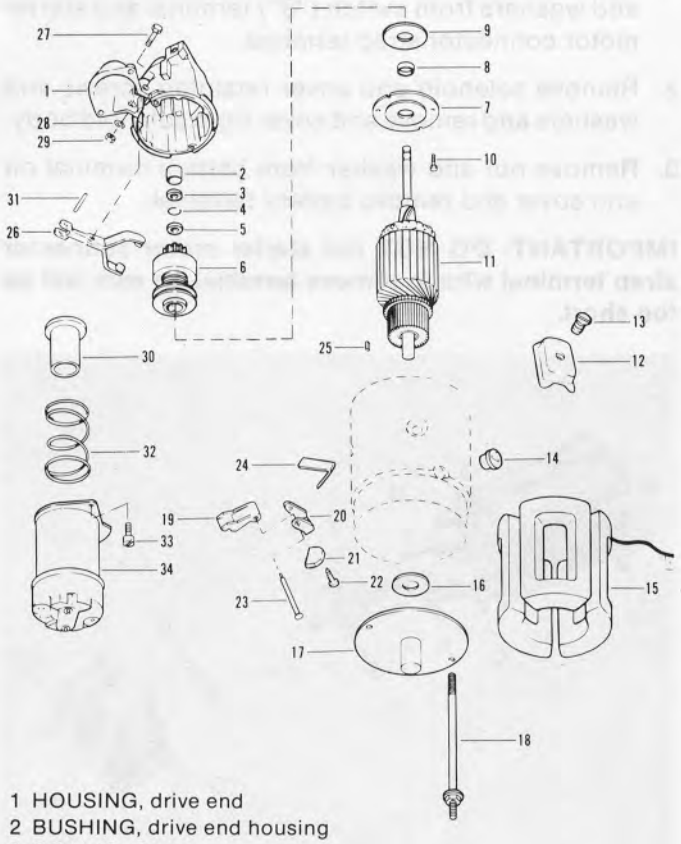
Starting System Components



a - Ignition Switch
b - Neutral Start Switch
c - Slave Solenoid
d - Circuit Breaker
e - Engine Ground Stud
f - Starter Solenoid
g - 20-Amp Fuse

BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

Starter Motor Assembly



1 HOUSING, drive end
2 BUSHING, drive end housing
3 COLLAR, thrust
4 RING, retaining - pinion stop collar
5 COLLAR, pinion stop
6 DRIVE ASSEMBLY, clutch
7 PLATE, bearing
8 BUSHING, bearing plate
9 WASHER, bearing plate
10 SCREW, bearing plate
11 ARMATURE
12 SHOE, pole - field coil
13 SCREW, pole shoe to field coil
14 GROMMET, field coil - field frame
15 FIELD COIL ASSEMBLY
16 WASHER, leather - commutator end frame
17 FRAME, commutator end - lower
18 BOLT, thru
19 HOLDER, insulated - field frame brush
20 HOLDER, field frame brush ground
21 BRUSH, field frame
22 SCREW, brush lead
23 SUPPORT PACKAGE, ground and insulated holders
24 SPRING, field frame brush
25 PIN, dowel - field frame
26 LEVER, shift
27 STUD, shift lever
28 WASHER, shift lever stud
29 NUT, shift lever stud
30 PLUNGER, shift lever
31 PIN, plunger to shift lever
32 SPRING, plunger return
33 SCREW, solenoid switch
34 SOLENOID SWITCH ASSEMBLY

Notice

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required:

a. Inspect terminals for corrosion and loose connections.

b. Inspect wiring for frayed and worn insulation.

c. Check mounting bolts for tightness.

Repair

Removal

⚠WARNING

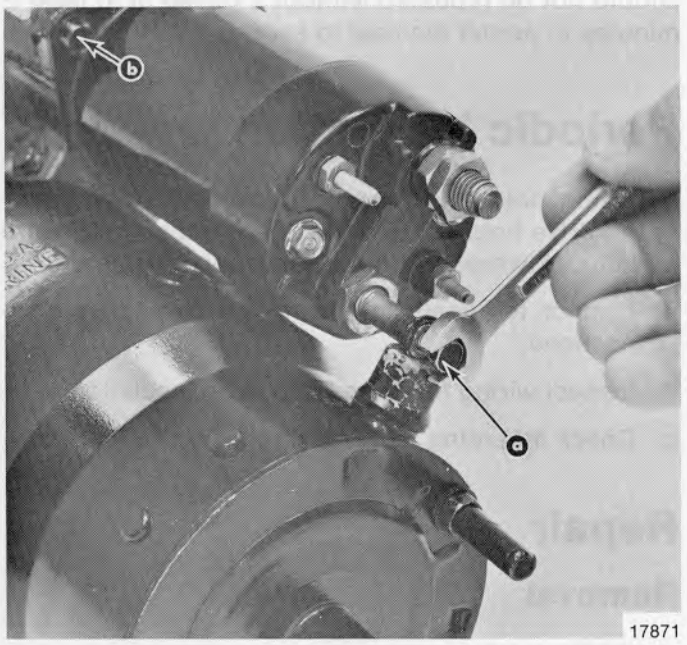
Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.
3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Solenoid Switch

REMOVAL

1. Remove starter motor as outlined.
2. Remove screw from field coil connector and solenoid attaching screws.
3. Twist solenoid to disengage tab, and remove.

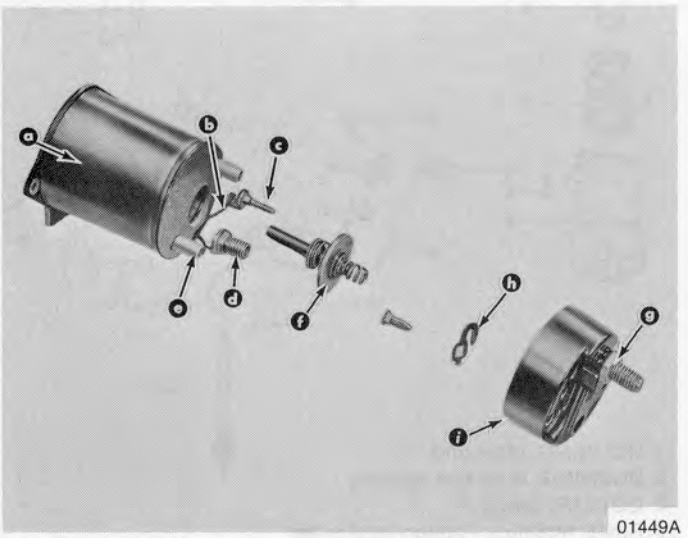


a - Field Coil Screw
b - Attaching Screws

REPLACEMENT of CONTACTS

1. With solenoid removed from motor, remove nuts and washers from switch ("S") terminal and starter motor connector strap terminal.
2. Remove solenoid end cover retaining screws and washers and remove end cover from solenoid body.
3. Remove nut and washer from battery terminal on end cover and remove battery terminal.

IMPORTANT: DO NOT cut starter motor connector strap terminal wire to remove terminal, or wire will be too short.



a - Solenoid Body
b - To Hold in Coil
c - Switch Terminal
d - Motor Connector Strap Terminal
e - To Pull in Coil
f - Contact Ring and Push Rod Assembly
g - Battery Terminal
h - Contact Finger
i - End Cover

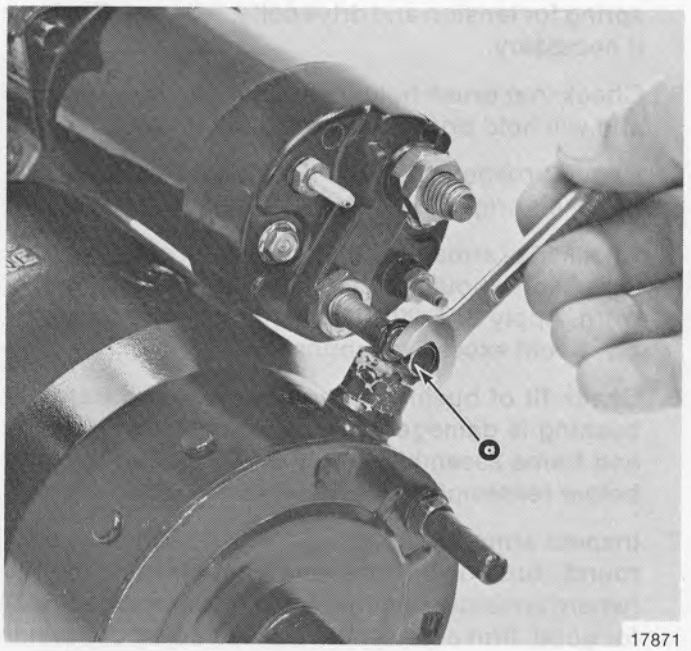
4. Remove motor connector strap terminal and solder new terminal in position.
5. Remove and install new battery terminal, washer and retaining nut to end cover.
6. Place new contact ring and push rod assembly in solenoid housing.
7. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

INSTALLATION

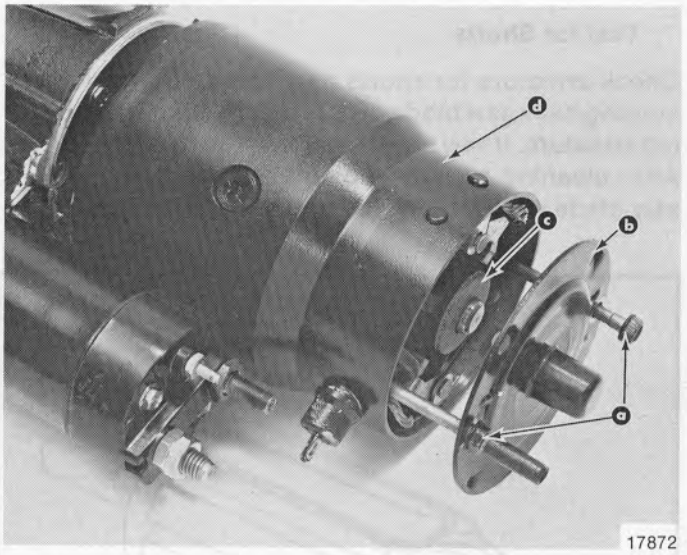
1. Install solenoid onto plunger.
2. Twist solenoid to engage tab.
3. Install screws and tighten securely.
4. Install field coil connector screw.

Starter Motor Disassembly

1. Remove screw from field coil connector.

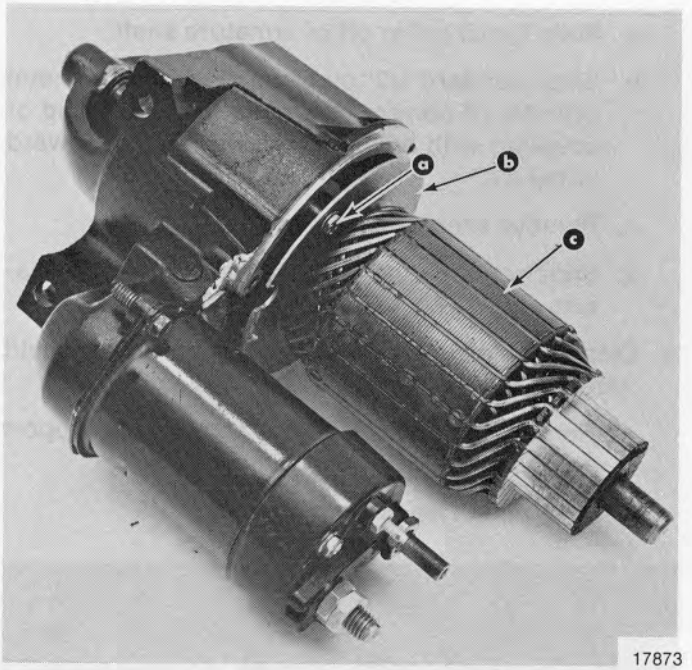


2. Remove end frame thru bolts, end frame, washer and field frame.



a - Thru Bolts
b - End Frame
c - Washer
d - Field Frame

3. Remove screws, center bearing plate and armature.



a - Screws
b - Bearing Plate
c - Armature

4. Remove over-running clutch from armature shaft as follows:
   a. Slide thrust collar off of armature shaft.
   b. Slide standard 1/2" pipe coupling or other metal cylinder of correct size onto shaft. Tap end of coupling with hammer, driving retainer toward armature.
   c. Remove snap ring from groove.
   d. Slide retainer and clutch assembly from armature shaft.
5. Disassemble brushes and related parts from field frame as follows:
   a. Remove pin, which passes thru brush support and brush holders, and remove.
   b. Disconnect leads from brushes.

a - Cylinder
b - Retainer

Driving Off Retainer

Cleaning and Inspection

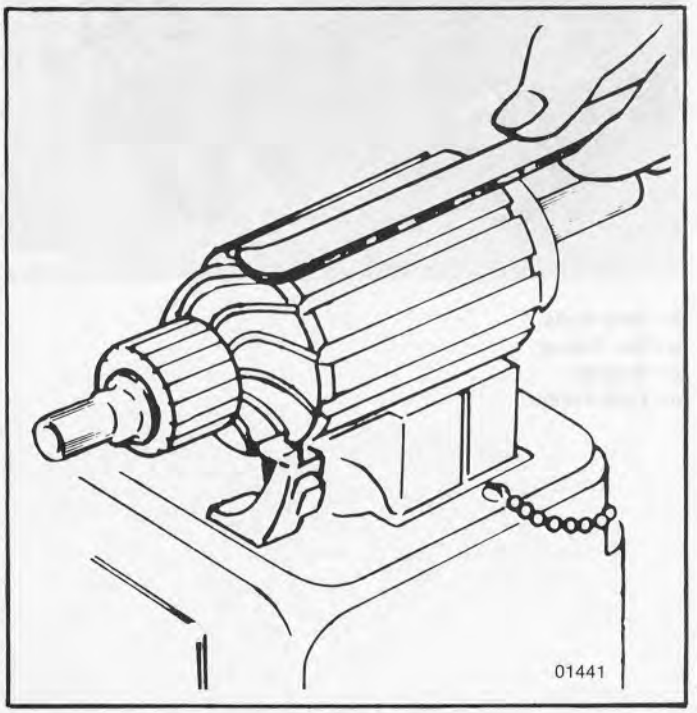
With starting motor completely disassembled, except for removal of field coils, component parts should be cleaned and inspected. Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

1. Clean all starting motor parts but do not use dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.
2. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.
3. Check that brush holders are not damaged or bent and will hold brushes against commutator.
4. Check brushes. Replace if pitted or worn to one-half their original length [5/16" (8mm) or less].
5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly. Replace bushing, if worn. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.
6. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.
7. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar usually is evidence of poor connection.

ARMATURE TESTS

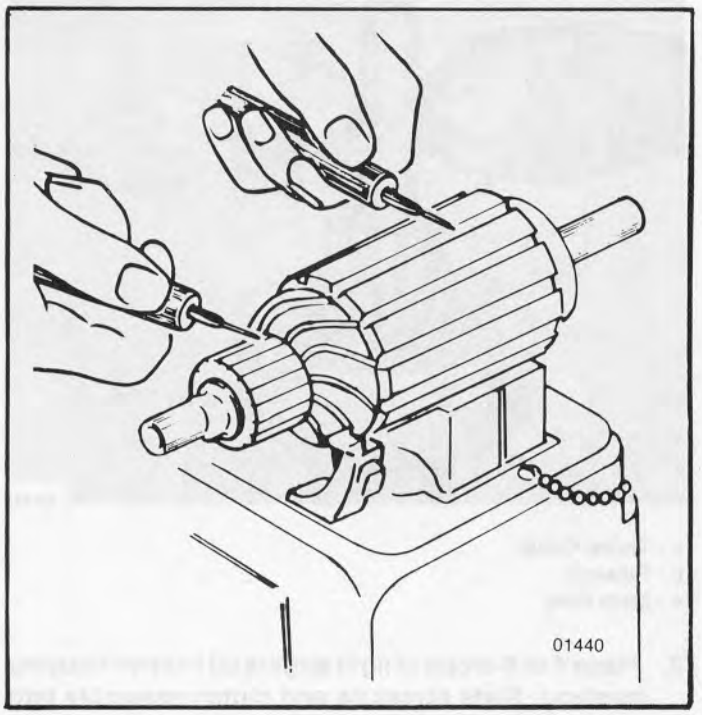
Test for Shorts

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.



Test for Ground

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves armature is grounded and must be replaced.



FIELD COIL TESTS

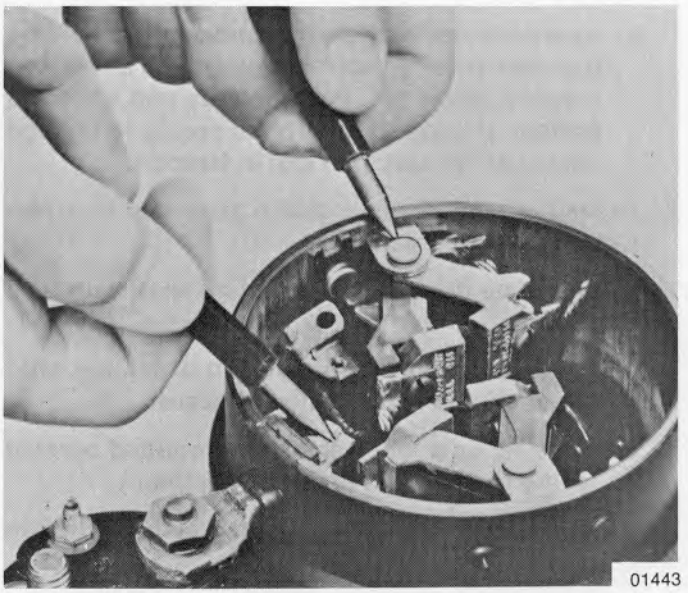
Test for Open Circuit

1. With continuity meter, place one lead on each end of field coils (insulated brush and field connector bar).
2. If meter does not move, field coils are open and must be replaced.

Test for Ground

IMPORTANT: Be sure that positive brushes and leads do not contact field frame assembly during test, or false reading will result.

1. With continuity meter, place one lead on field connector bar and other lead on grounded brush.
2. If meter moves, field coils are grounded and must be replaced.



LOOSE ELECTRICAL CONNECTIONS

If open soldered connection of armature to commutator leads is found during inspection, resolder with rosin flux.

IMPORTANT: NEVER USE ACID FLUX ON ELECTRICAL CONNECTIONS.

Turning the Commutator

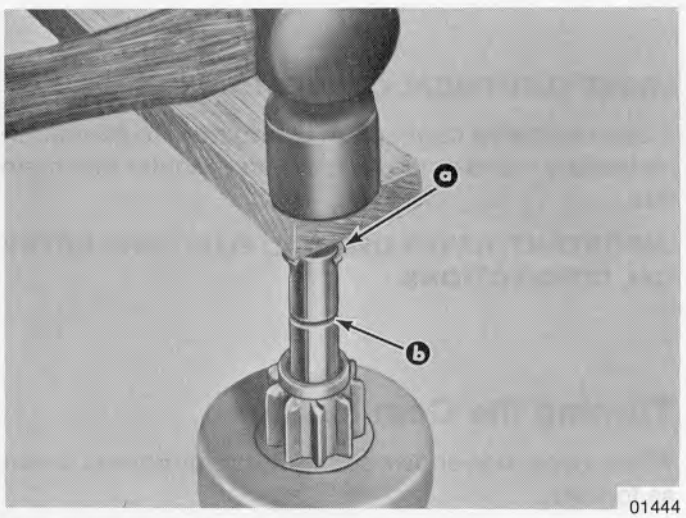
When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.
2. Recheck armature for shorts as outlined.

Reassembly

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter as follows:

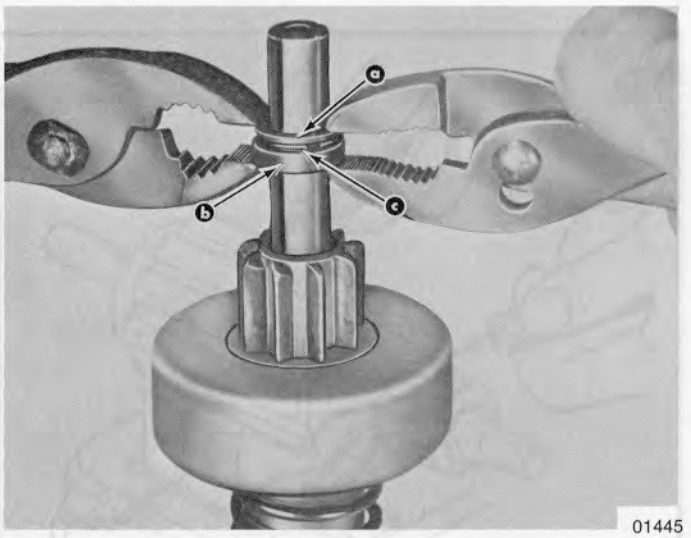
1. Assemble brushes and related parts to field frame as follows:
   a. Assemble brushes to brush holders. Attach ground wire to grounded brush and field lead wire to insulated brush.
   b. Assemble insulated and grounded brush holders together with "V" spring. Position as a unit and install support pin. Push holders and spring to bottom of support and rotate spring to engage center of "V" spring in slot in support.
2. Assemble over-running clutch assembly to armature shaft as follows:
   a. Lubricate drive end of armature shaft with SAE 10 oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Drive snap ring onto shaft and slide down into groove.



01444

a - Snap Ring
b - Groove

   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Place thrust collar and retainer next to snap ring and using 2 pliers squeeze both until snap ring is forced into retainer.

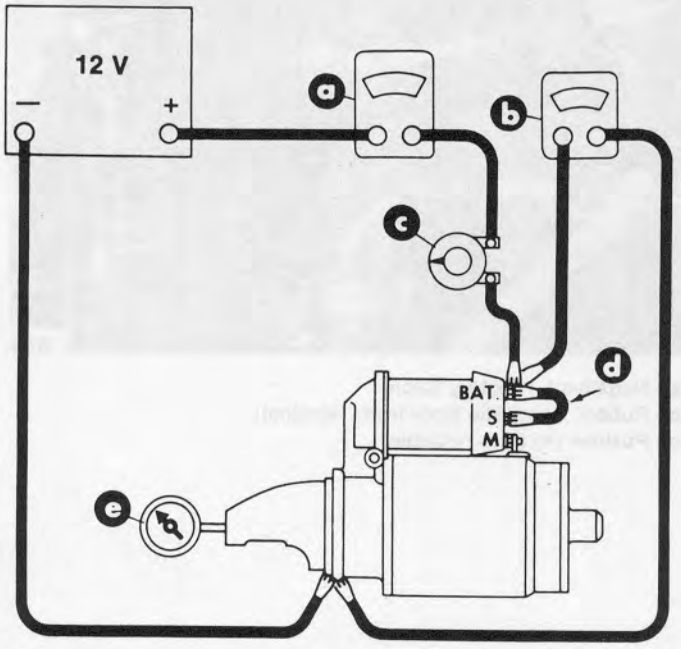


01445

a - Thrust Collar
b - Retainer
c - Snap Ring

3. Place 4 or 5 drops of light engine oil in drive housing bushing. Slide armature and clutch assembly into place while engaging shift lever with clutch.
4. Position field frame over armature and apply Liquid Neoprene between frame against drive housing, observing caution to prevent damage to brushes.
5. Place 4 to 5 drops of light engine oil in bushing in commutator end frame. Place brake washer and commutator end frame onto shaft.
6. Install solenoid return spring on plunger.

7. After reassembly, a "no load" check of starting motor may be made if equipment is available. To check, connect starter motor in series with a fully-charged 12-volt battery, an ammeter capable of reading several hundred amperes and a variable resistance.
8. Also, connect a voltmeter, as illustrated, from motor terminal to motor frame. An RPM indicator is necessary to measure armature speed. Obtain specified voltage by varying resistance unit. Then read current draw and armature speed and compare these readings with specifications.



01446

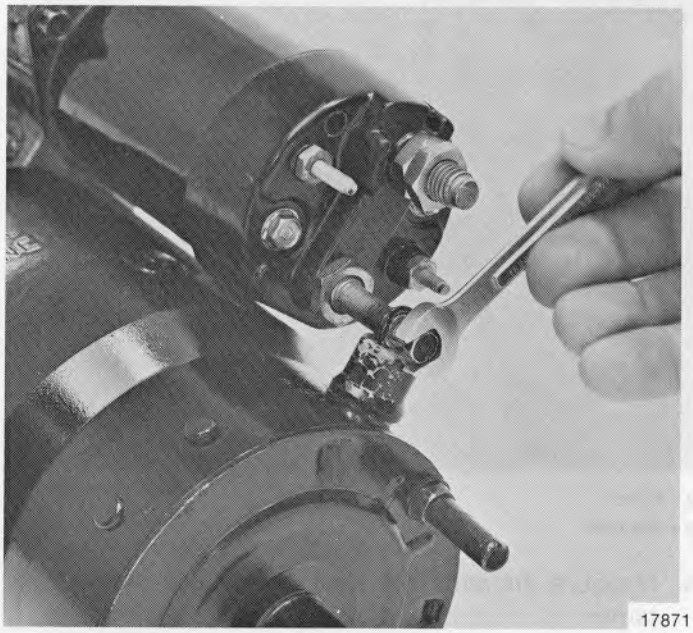
a - Ammeter
b - Voltmeter
c - Variable Resistor
d - Jumper Lead
e - RPM Indicator

Clearances

PINION CLEARANCE

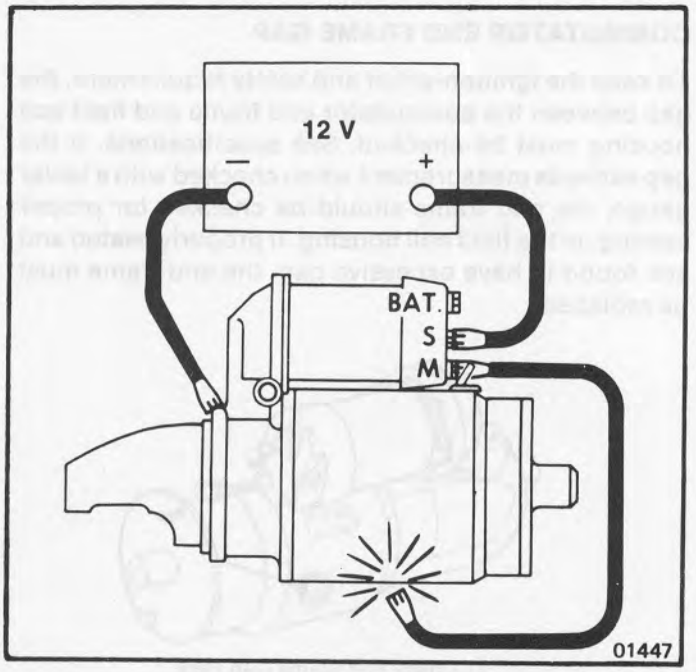
Pinion clearance must be checked as follows after reassembly of motor to insure proper adjustment.

1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.



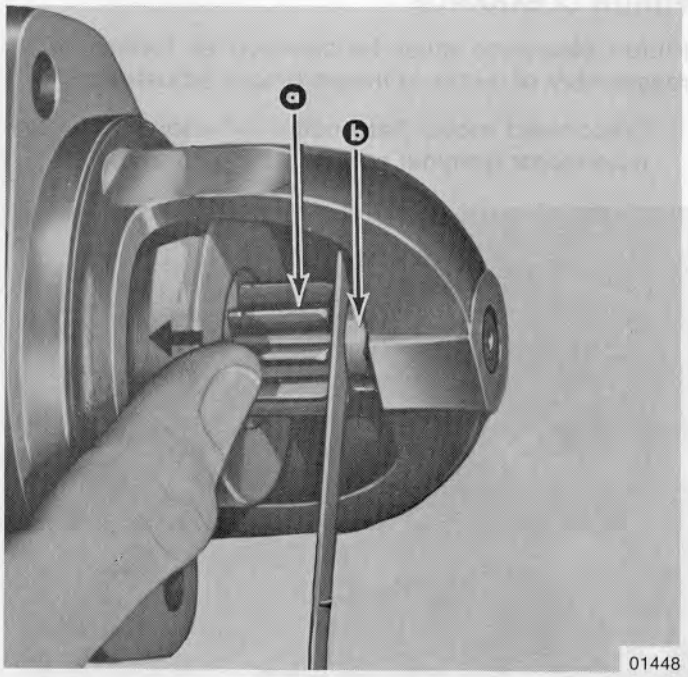
17871

2. Connect 12-volt battery from solenoid switch(s) terminal to solenoid frame.
3. Momentarily touch a jumper lead from solenoid motor terminal to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



01447

4. Push pinion back toward commutator end to eliminate slack.

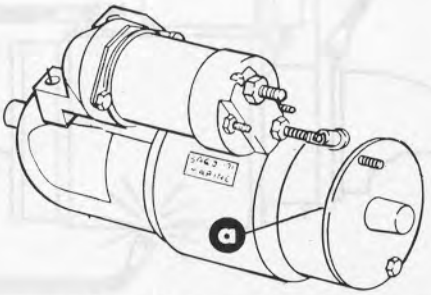


a - Pinion
b - Retainer

5. Measure distance between pinion and pinion retainer.
6. If clearance is not within specified limits, it may indicate excessive wear of solenoid linkage shift lever yoke buttons or improper assembly of shift lever mechanism. Check for proper assembly, and recheck gap. If still excessive, replace worn or defective parts, since no provision is made for adjusting pinion clearance.

COMMUTATOR END FRAME GAP

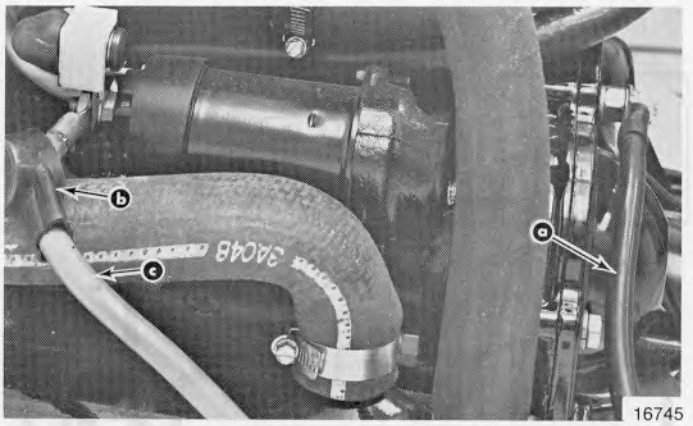
To keep the ignition-proof and safety requirement, the gap between the commutator end frame and field coil housing must be checked. See specifications. If the gap exceeds measurement when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the end frame must be replaced.



a - Check End Frame Gap Here

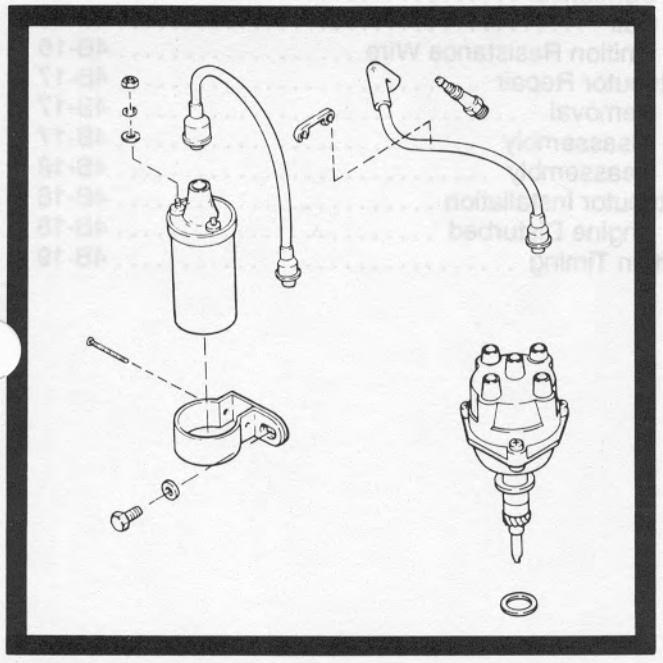
Installation

1. Place starter motor and solenoid assembly in position and install mounting bolts.
2. Fasten wires as outlined in wiring diagram.
3. Coat solenoid terminal connections with Liquid Neoprene.
4. Place rubber boot over positive battery cable connection.



a - Negative (-) Battery Cable
b - Rubber Boot (Slid Back from Terminal)
c - Positive (+) Battery Cable

ELECTRICAL SYSTEMS



4

B

IGNITION SYSTEM

mercruiser
STERN DRIVES & INBOARDS

INDEX

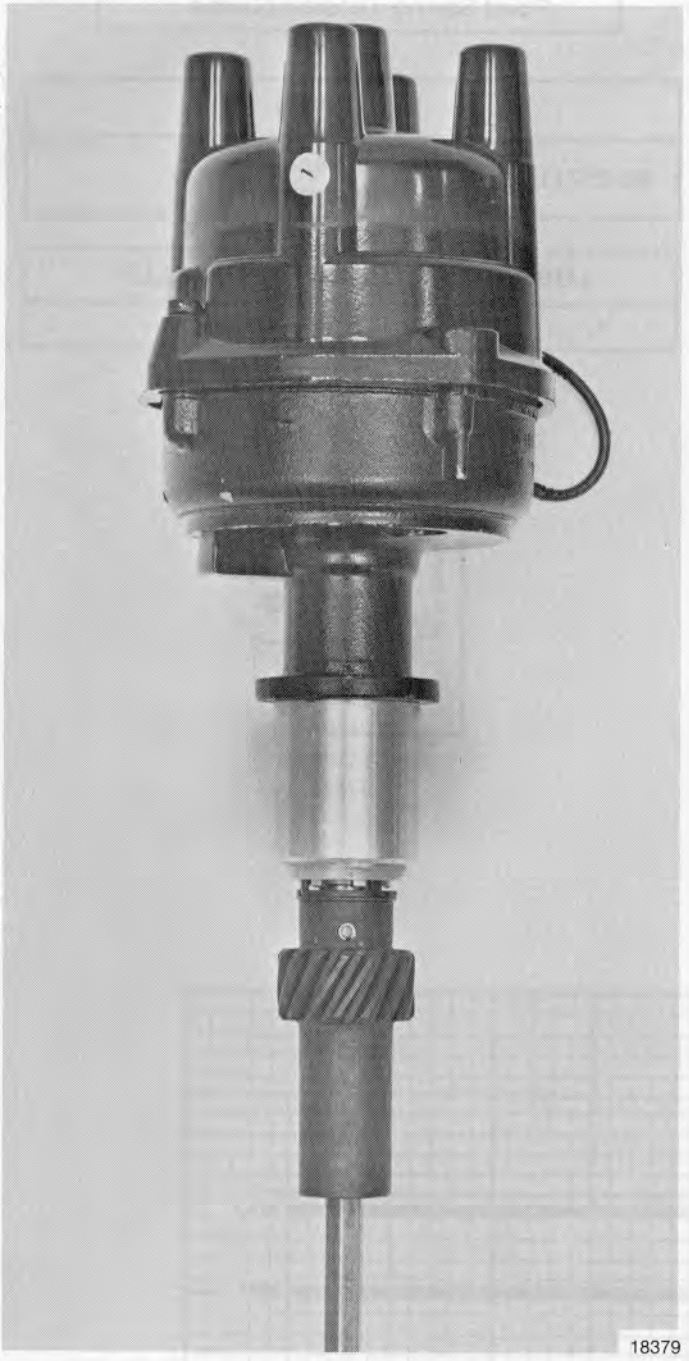
Delco Distributor — Page

Identification 4B-1
Precautions 4B-1
Breaker Point Ignition System 4B-1
Specifications 4B-1
Torque Specifications 4B-2
Tool/Lubricants/Sealants 4B-2
Distributor Advance Curve 4B-2
Wiring Diagram 170/190 ..... 4B-3
Repair 4B-4
Distributor Cap and Rotor 4B-4
Ignition Points Inspection 4B-4
Cleaning 4B-4
Burned Points 4B-4
Pitted Points 4B-5
Replacement 4B-5
Lubrication 4B-5
Checking Spring Tension 4B-5
Setting Point Alignment and Dwell 4B-5
Condenser 4B-6
Ignition Coil Testing 4B-6
Ignition Resistance Wire 4B-6
Spark Plug 4B-7
Spark Plug Wires 4B-7
Distributor Repair 4B-7
Inspection on Engine 4B-7
Removal 4B-8
Disassembly 4B-8
Inspection/Cleaning 4B-9
Reassembly 4B-9
Distributor Installation 4B-10
Engine Not Disturbed 4B-10
Engine Disturbed 4B-10
Ignition Timing 4B-10

Prestolite Distributor

Identification 4B-11
Replacement Parts Warning 4B-11
Specifications 4B-11
Torque Specifications 4B-11
Tools/Lubricants/Sealants 4B-11
Distributor Advance Curve 4B-12
Repair 4B-13
Precautions 4B-13
Distributor Cap and Rotor 4B-13
Contact Points 4B-13
Abnormal Point Wear 4B-14
Cleaning Points 4B-14
Burned Points 4B-14
Pitted Points 4B-14
Replacement 4B-15
Point Adjustment 4B-15
Dwell Adjustment 4B-15
Condenser 4B-16
Coil 4B-16
Ignition Resistance Wire 4B-16
Distributor Repair 4B-17
Removal 4B-17
Disassembly 4B-17
Reassembly 4B-18
Distributor Installation 4B-18
Engine Disturbed 4B-18
Ignition Timing 4B-19

Identification



Delco Distributor

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimuze risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulation, could result in a fire or explosion hazard and sould be avoided.

Precautions

⚠WARNING

When testing or servicing the ignition system, it is of extreme importance that the following precautions be observed, as high voltage is present. DO NOT touch or disconnect any ignition system parts while engine is running, key switch is on, or while battery cables are connected. Follow test procedures carefully.

Failure to comply with the following may result in damage to the ignition system.

A. Do not reverse battery cable connections at the battery. System is negative (-) ground.

B. Do not "spark" battery terminals with battery cable connectors to check polarity.

C. Do not disconnect battery cables while engine is running.

D. Follow service procedures in the order listed.

Breaker Point Ignition

Specifications

ENGINE MODEL	ALL
Resistor Wire (Ohms)	1.8 - 2
Spark Plug Type	Quicksilver 33-75339 AC R42TS Champion RV9YC
Spark Plug Gap	.035 (.9mm)
Point Gap	.022 (.5mm)
Point Dwell	28 - 34°
Point Spring Tension	10 - 23 oz. (540 - 650g)
Timing	4° BTDC
Condenser	.18 - .25 MFD
Coil	Part Number 32193A2
Coil Primary Resistance Min.	1.1 Ohms
Coil Primary Resis-	1.5 Ohms
Coil Secondary Resistance	9,400 - 11,7000 Ohms

Torque Specifications

FASTENER	LBS. FT. (N.m) LBS. IN. (N.m)
Distributor Hold Down	15 (20)
Spark Plug	15 (20)

Tools/Lubricants/Sealants

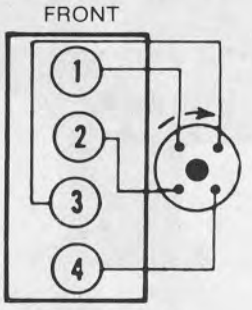
MERCURY MARINE SPECIAL TOOLS	
91-59339	Dwell Meter
91-76032	Magneto Analyzer
91-52024A1	Remote Starter Switch
91-99379	Timing Light
91-99750	Volt/Ohm Meter

TOOLS OBTAINED LOCALLY
Point Spring Tension Gauge

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

LUBRICANTS OBTAINED LOCALLY
Distributor Cam Lubricant

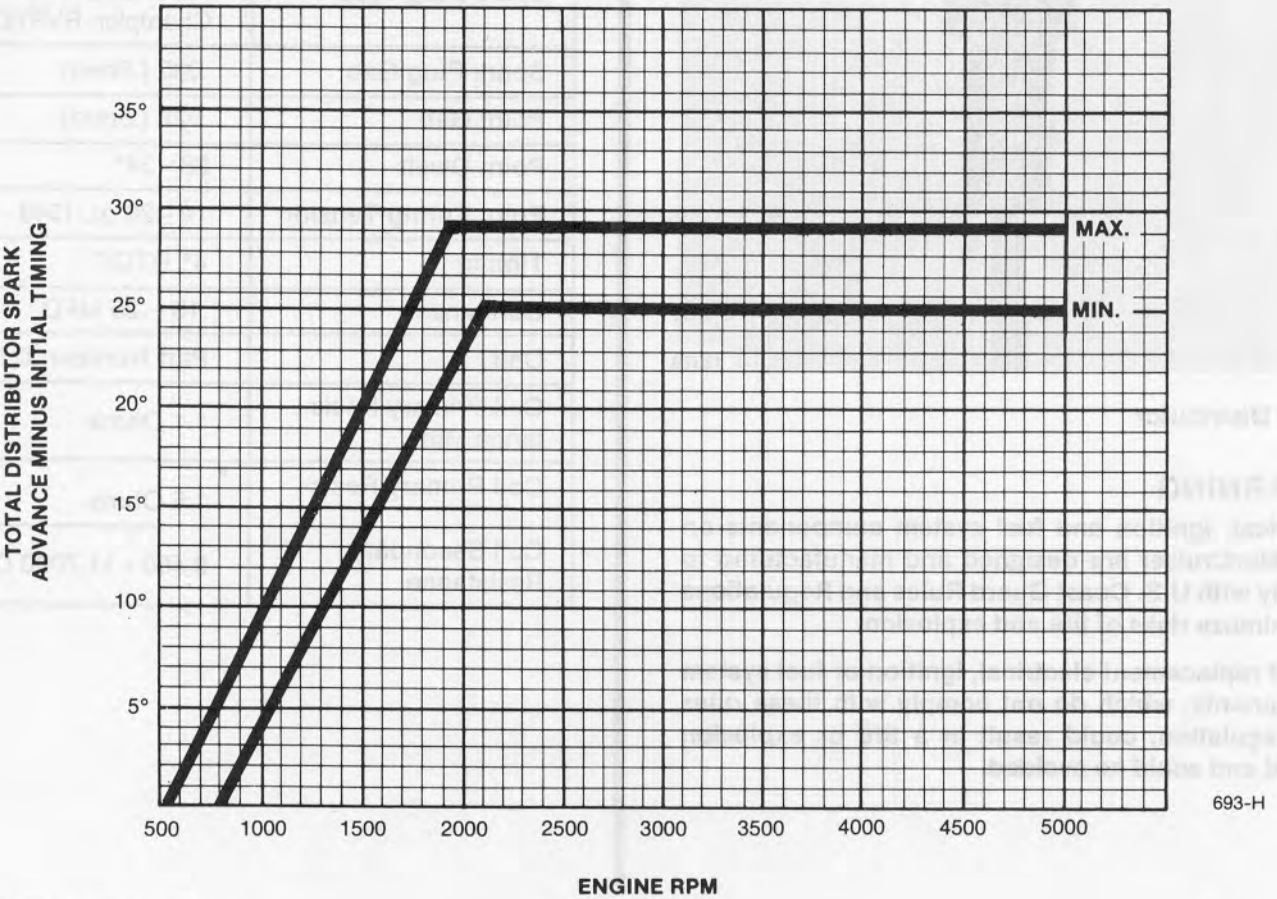
FIRING ORDER

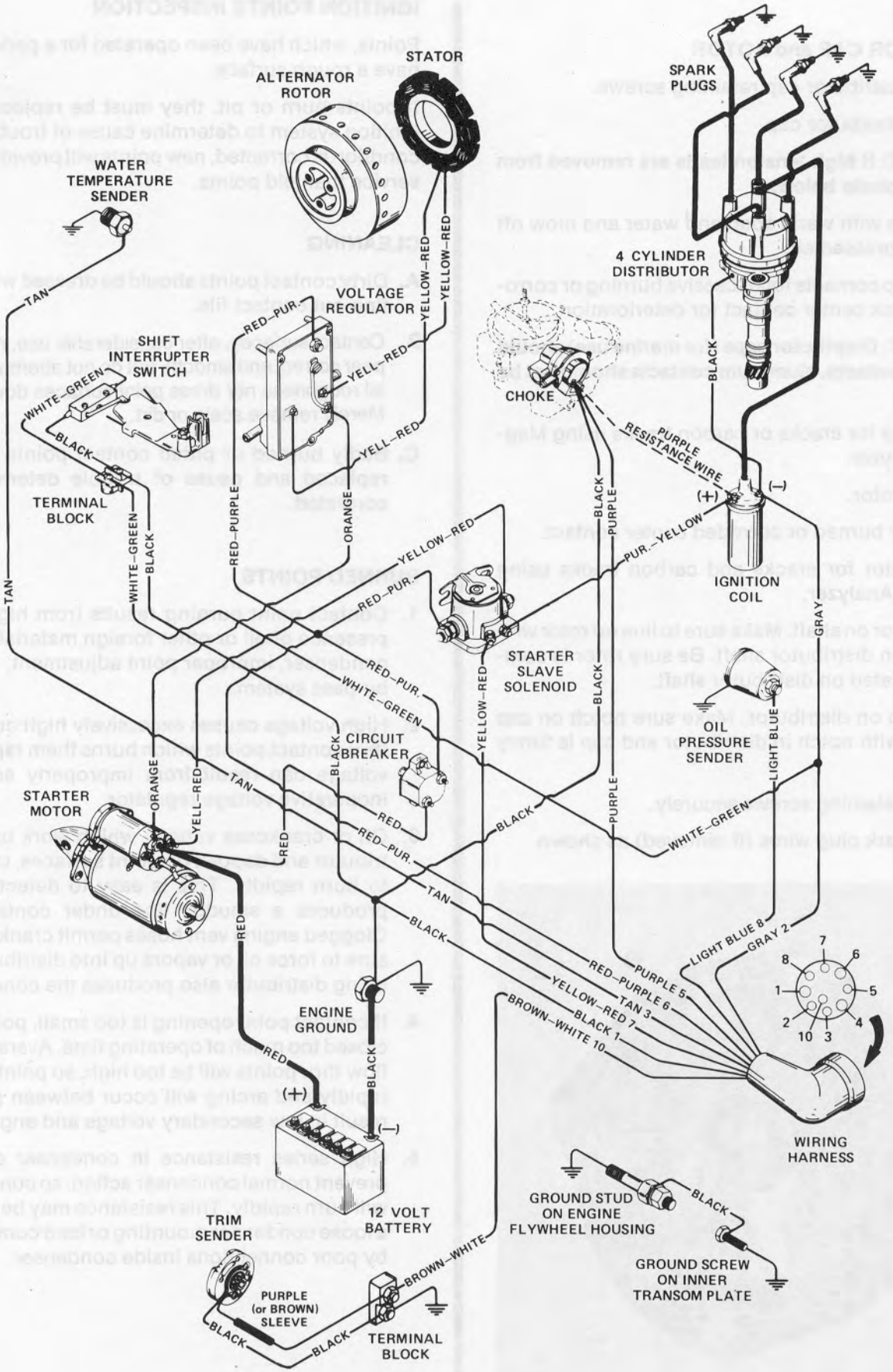


FIRING ORDER
1-3-4-2

DISTRIBUTOR ADVANCE CURVE 170/190

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.





WIRING DIAGRAM

192 H-3

Repair

DISTRIBUTOR CAP and ROTOR

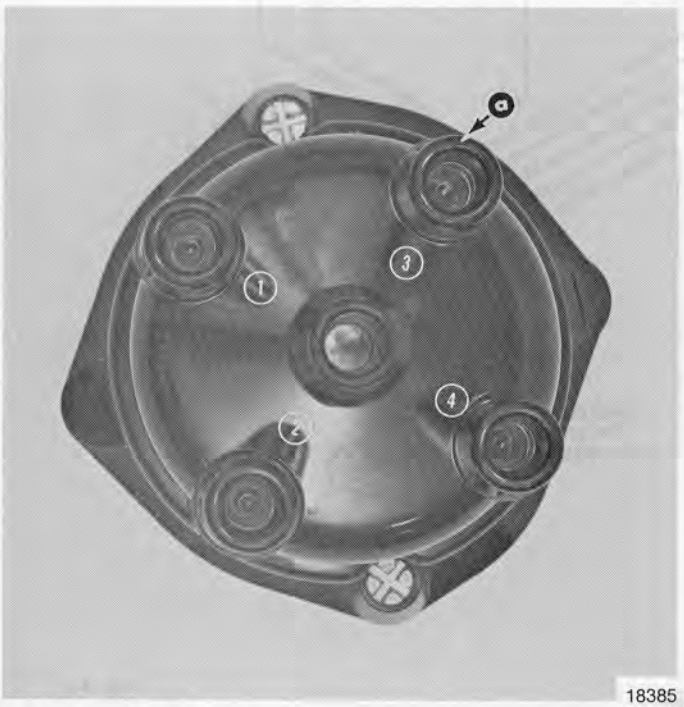
1. Loosen distributor cap retaining screws.
2. Remove distibutor cap.

IMPORTANT: If high tension leads are removed from cap refer to photo below.

3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contacts for excessive burning or corrosion. Check center contact for deterioration.

IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

5. Check cap for cracks or carbon tracks using Magneto Analyzer.
6. Remove rotor.
7. Check for burned or corroded center contact.
8. Check rotor for cracks and carbon tracks using Magneto Analyzer.
9. Install rotor on shaft. Make sure to line up rotor with keyway on distributor shaft. Be sure rotor is completely seated on distributor shaft.
10. Place cap on distributor. Make sure notch on cap lines up with notch in distributor and cap is firmly seated.
11. Tighten retaining screws securely.
12. Install spark plug wires (if removed) as shown.



a - Alignment Notch Location

4 Cylinder Distributor Cap Wiring

IGNITION POINTS INSPECTION

Points, which have been operated for a period of time, have a rough surface.

If points burn or pit, they must be replaced. Check ignition system to determine cause of trouble. Unless condtion is corrected, new points will provide no better service than old points.

CLEANING

A. Dirty contact points should be dressed with a clean, fine-cut contact file.

B. Contact surfaces, after considerable use, may not appear correct and smooth, but do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.

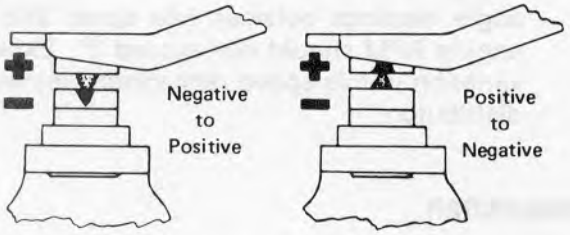
C. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

BURNED POINTS

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser, improper point adjustment, or ignition by-pass system.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly. This is easy to detect, since oil produces a smudgy line under contact points. Clogged engine vent hoses permit crankcase pressure to force oil or vapors up into distributor. Over-oiling distributor also produces the condition.
4. If contact point opening is too small, points will be closed too much of operating time. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points and result in low secondary voltage and engine miss.
5. High series resistance in condenser circuit will prevent normal condenser action, so contact points will burn rapidly. This resistance may be caused by a loose condenser mounting or lead connection, or by poor connections inside condenser.

PITTED POINTS

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other.



2. Direction, in which material transfers, can be used as a basis for analysis and correction of pitting. For example, if material transfers form negative to positive point one or more of these corrections may be made. Increase condenser capacity, shorten condenser lead, separate distributor-to-coil low and high-tension leads or move these leads closer to ground.

3. If material transfers from positive to negative point, reduce condenser capacity, move distributor-to-coil leads closer together, move these leads away from ground or lengthen condenser lead.

REPLACEMENT

1. Remove distributor cap.
2. Remove rotor.
3. Remove breaker plate.
4. Remove primary terminal screw.
5. Remove contact point set from breaker plate.
6. Clean breaker plate.

IMPORTANT: Wipe protective film from point set prior to installation.

7. Install new contact point assembly.
8. Connect primary and condenser lead wires to terminal on primary terminal screw.

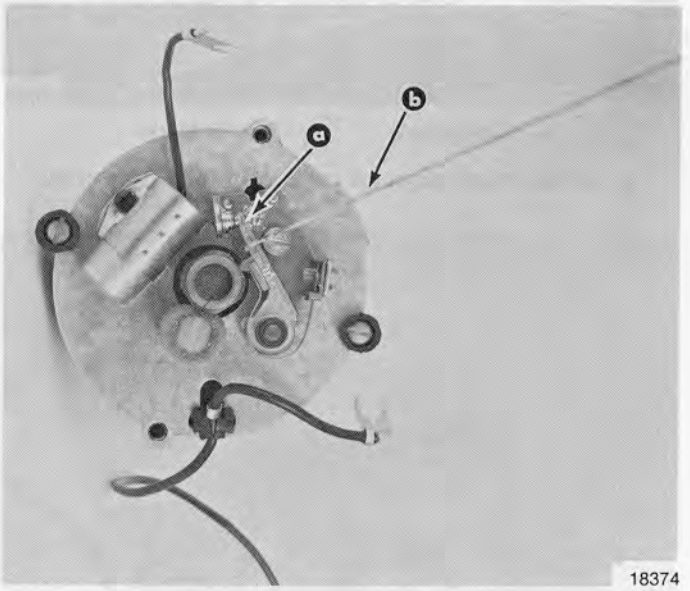
LUBRICATION

Apply a light film of suitable high melting point, non-bleeding grease on distributor cam. Repeat every 50 hours of operation or once a year.

CHECKING SPRING TENSION

Contact point pressure must fall within specified limits. Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block.

Contact point pressure should be checked with a spring gauge. Scale should be hooked to breaker lever and pull exerted at 90° to breaker lever. Reading should be taken just as points separate. Refer to specifications for spring tension. Pressure can be adjusted by bending breaker lever spring. If pressure is excessive, it can be decreased by pinching spring carefully. To increase pressure, remove lever from distributor so that spring can be bent away from lever.



a - Movable Contact
b - Spring Tension Gauge

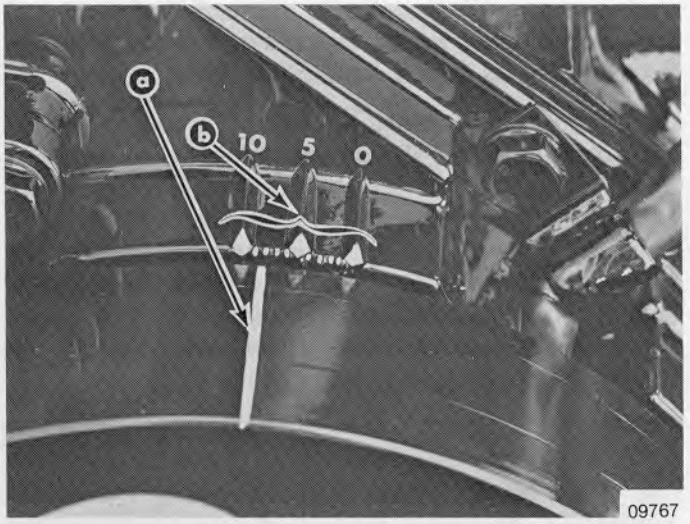
SETTING POINT ALIGNMENT and DWELL

1. Set contact points with a feeler gauge to specifications.
2. New points must be set to high side of gap, as rubbing block will wear while seating to cam. Points should be cleaned before adjusting if previously in service.

Adjust point opening as follows:

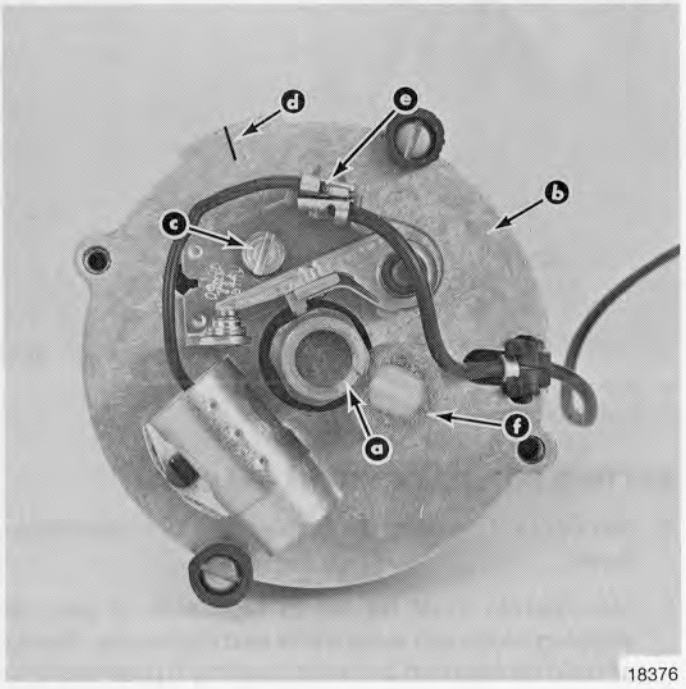
a. Align points by bending fixed contact support. Do not bend breaker lever. Align new points but replace used points if bent.

b. Rotate engine until timing mark on harmonic balancer lines up with "O" (TDC) on timing tab and engine is in #1 firing position.



a - Timing Mark b - Degree Marks

c. A lob must align on rubbing block of points.



a - Rotor Alignment Notch
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Alignment Mark
e - Quick Disconnect Terminal
f - Lubrication Wick

d. Loosen breaker point retaining screw(s).

e. Use adjusting slots adjusting screw to obtain correct gap for points.

f. Tighten retaining screw(s) and recheck point opening.

g. After checking and adjusting contact point opening to specifications, cam angle or dwell should be checked with a dwell meter.

h. If cam angle is less than specified minimum, check for defective or misaligned contact points or worn distributor cam lobes. Variation in cam angle readings between idle speed and 1750 engine RPM should not exceed 3°. Excessive variation in this speed range indicates wear in distributor.

CONDENSER

Testing/Replacement

Use a magneto analyzer to make the following checks:

1. Condenser capacity.
2. Condenser shorts or leak.
3. Condenser series resistance.

Refer to specifications and replace coil if not within specifications.

IGNITION COIL TESTING

Use a magneto analyzer to make the following checks:

1. Disconnect wire from positive (+) side of coil.
2. Coil surface insulation.
3. Coil continuity.
4. Primary resistance.

Refer to specifications and replace condenser if not within specifications.

IGNITION RESISTANCE WIRE

Engine with Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wires. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. For instructions on replacing resistor wire refer to "Section 4, Par C".

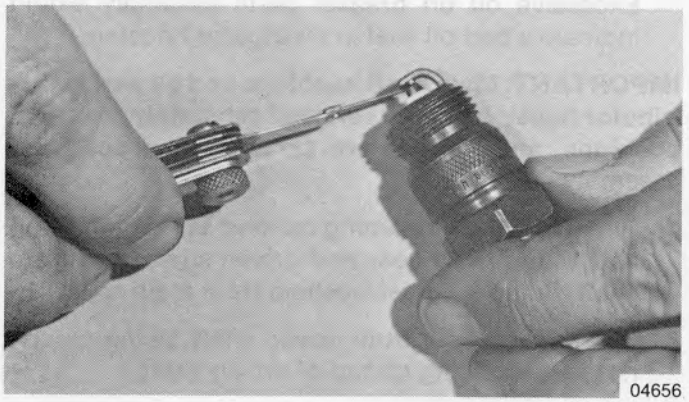
SPARK PLUG

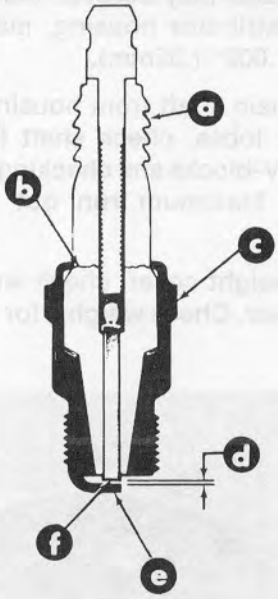
Inspection/Replacement

1. Inspect every 100 hours.
2. All plugs must be the same make and number.

IMPORTANT: Bend only side electrode to adjust gap.

3. Adjust gap with a round feeler gauge.





a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File Flat When Adjusting Gap - Do Not Bend)

4. Clean plug seat area. Do not use gaskets on taper seat plugs.
5. Install and torque to specifications.

SPARK PLUG WIRES

Inspection

1. Check that all wires are clean and tight.
2. Check all boots for cracks or deterioration.
3. Replace as necessary.
4. Check that all wires are at proper locations.

Distributor Repair

INSPECTION ON ENGINE

1. Remove distributor cap and inspect as outlined. Replace if necessary.
2. Make sure that all distributor wire terminals are clean and tight.
3. Clean and inspect rotor and breaker assembly. Replace if necessary.
4. Test condensor as outlined. Replace if necessary.
5. Check distributor bushings for wear. Attach dial indicator to distributor housing. Position registering point of dial indicator to rest on distributor shaft. Shaft must not have more than .002" (.05mm) side play within bushings when shaft is pushed back-and-forth by hand.
6. Check for sticking centrifugal weights. Grip distributor shaft (or rotor) and twist in direction of rotation, then release. Shaft should snap back to its original position. If it hangs up, returns sluggishly or slowly, shaft assembly must be replaced, or rebuilt.

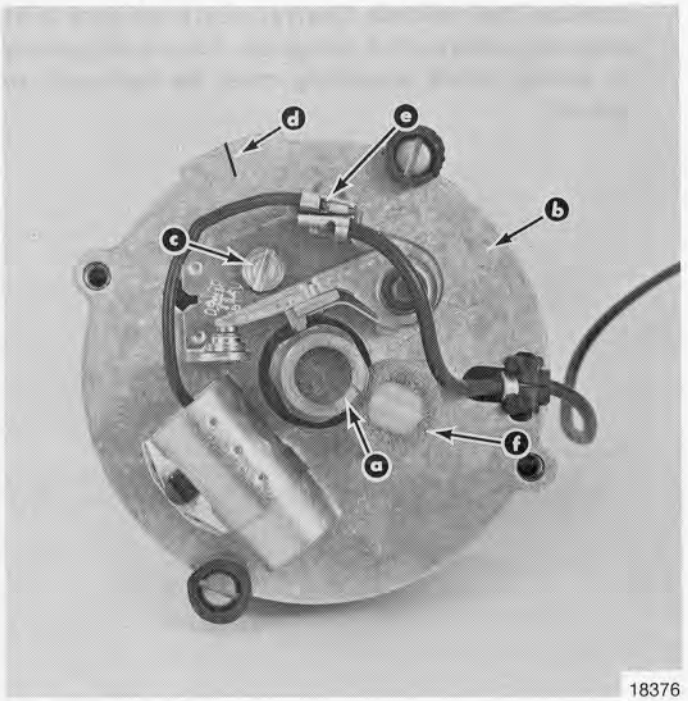
REMOVAL

1. Disconnect distributor primary lead from coil terminal.
2. Remove distributor cap and rotor as outlined.

IMPORTANT: If necessary to remove leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.

3. Scratch a realignment mark on distributor in line with rotor notch (located on distributor shaft).
4. Mark distributor housing in relation to engine block for ease of installation.
5. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation.

IMPORTANT: Avoid rotating engine with distributor removed, as ignition timing will be upset.



18376

a - Rotor Alignment Notch
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Alignment Mark
e - Quick Disconnect Terminal
f - Lubrication Wick

DISASSEMBLY

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Remove condenser and breaker points from breaker plate. Test condenser and check breaker points as previously outlined.
2. Remove breaker plate from distributor housing. Excessive oil on breaker plate assembly would indicate a bad oil seal in distributor housing.

IMPORTANT: Main shaft bushings and oil seal in distributor housing are not serviced separately, housing, bushings, and oil seal are serviced as a complete assembly.

3. Remove roll pin retaining driven gear to main shaft and slide driven gear and driven shaft from main shaft. Remove thrust washers from main shaft.
4. Slide driven gear from driven shaft, being careful not to lose spring on top of driven shaft.
5. Check for side play between main shaft and bushings in distributor housing, maximum side play allowed is .002" (.05mm).
6. Remove main shaft from housing and inspect for worn cam lobes, check shaft for being bent by placing in V-blocks and checking run out with a dial indicator. Maximum run out allowed is .002" (.05mm).
7. Remove weight cover, check weights and weight stop for wear. Check weights for free movement on pins.

18610

a - Weight Cover
b - Weight Springs
c - Weights
d - Weight Stop

INSPECTION/CLEANING

1. Wash breaker plate, gear, collar and all washers and fasteners in cleaning solvent. If bushings are removed wash housing in solvent after removing coil lead wire. DO NOT wash points, condenser or any non-metal parts in solvent.
2. Inspect contact points as outlined. Replace if necessary.
3. Inspect advance weights for wear or burrs and free fit on their pins. If worn, replace distributor shaft assembly.
4. Inspect cam for wear or roughness. Check cam fit on end of shaft. It should be free, but not loose. If worn, replace distributor.

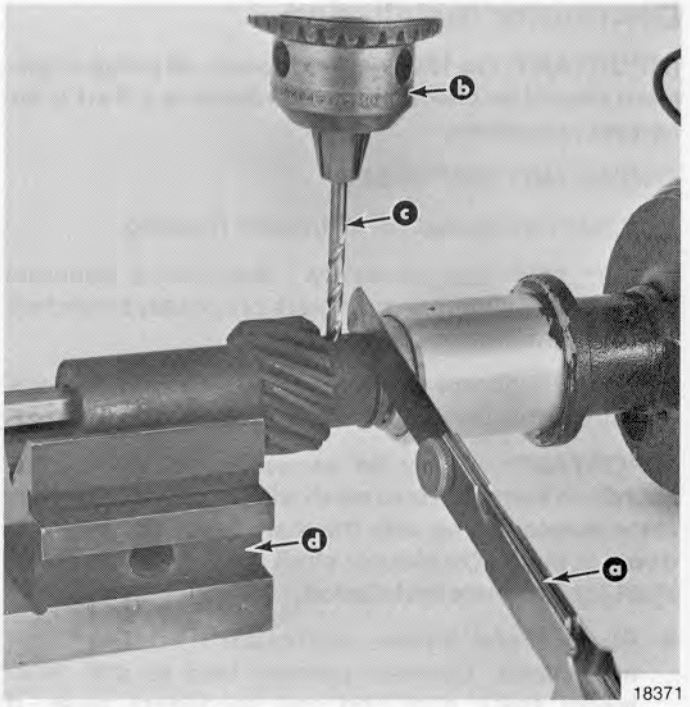
REASSEMBLY

1. Install weights and springs on pivot pins.
2. Install weight cover.
3. Lubricate main shaft with engine oil and install in distributor housing.
4. Install spring on drive shaft and install drive gear onto driven shaft.
5. Install thrust washers onto main shaft.
6. Install drive gear onto main shaft using one of the following methods.

   Used Gear: Line up holes in gear with hole in main shaft and install roll pin through gear and main shaft.

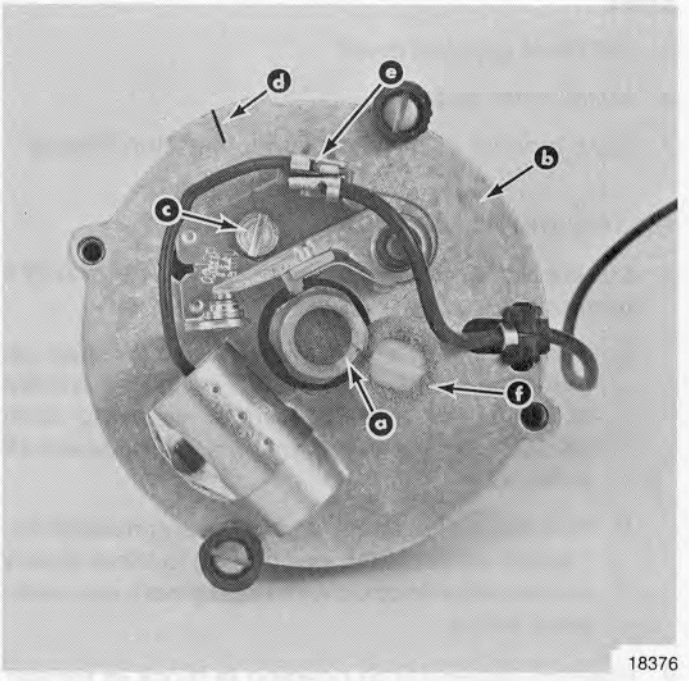
   New Gear: Hold a light downward pressure on distributor shaft. Install distributor gear onto distributor shaft. Insert a .030" feeler gauge between distributor housing washers and distributor gear. Position distributor shaft and new gear so you will drill the new hole 90° from the old hole in the distributor shaft. Place shaft and new gear on V-blocks and drill through gear and shaft. Install roll pin through gear and main shaft.

IMPORTANT: The hole should be drilled with a 5/32" carbide tipped drill. In most cases it is recommended to have a machine shop complete this operation.



18371

a - .030" (.75mm) Feeler Gauge - L.H. Rotation Engines Only
b - Drill Press
c - 5/32" Carbide Tipped Drill
d - V-Block



18376

a - Rotor Alignment Notch
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Alignment Mark
e - Quick Disconnect Terminal
f - Lubrication Wick

7. Install breaker plate on distributor housing.
8. Install condenser and breaker points on breaker plate.

Distributor Installation

IMPORTANT: On 170 and 190 models oil pump alignment should be checked, refer to Section 3, Part A for correct procedure.

ENGINE NOT DISTURBED

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specification", for firing order.

5. Set point gap and dwell.
6. Install rotor and cap.
7. Time ignition as outlined under "Ignition Timing".

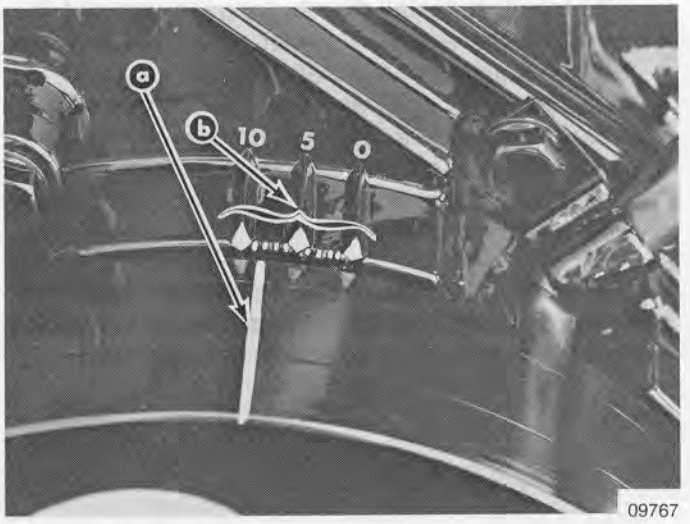
ENGINE DISTURBED

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or. . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more toward left and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to Specifications for firing order.
8. Set point gap and dwell.
9. Time ignition as outlined under "Ignition Timing".

Ignition Timing

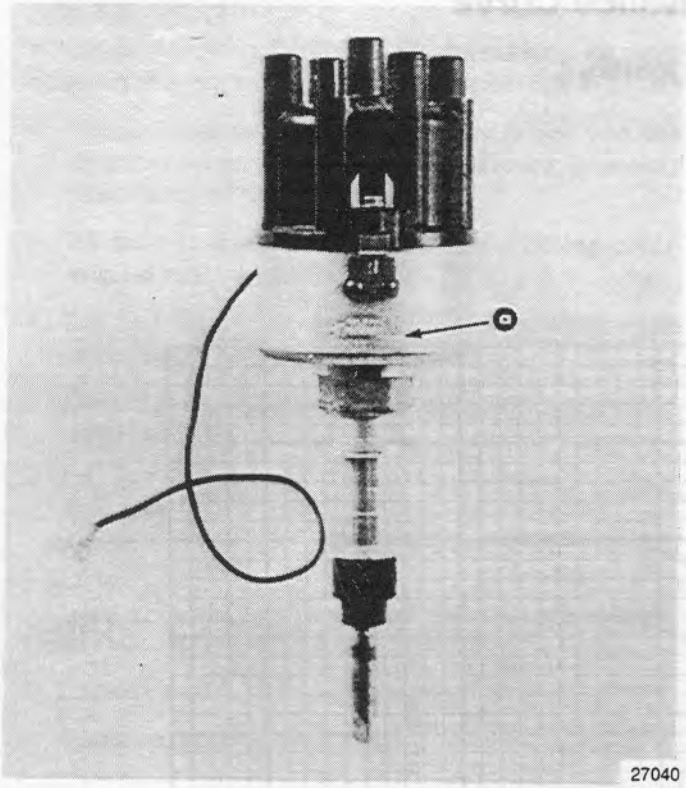
IMPORTANT: Dwell must be set to specification before adjusting timing.

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications' ' for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing marks as shown.
5. Adjust timing by loosenting distributor clamp and rotation distributor body as required until timing mark on balancer or pulley lines up ;with mark on tab specified in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine an dremove timing light.



a - Timing Mark
b - Degree Marks

Prestolite Distributor Identification



a - Identification Tag

PRESTOLITE DISTRIBUTOR MODELS (BREAKER POINTS IGNITION)

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Specifications

Distributor

Condenser*	.18-.25 mfd
Point Dwell	39-45 Degrees
Point Gap	.016 in. (0.5mm)
Point Spring Tension	20-27 oz. (567-765 g)
Timing	4 Degree BTDC
Spark Plug Gap	.35 in. (0.9 mm)

NOTE: *Use magneto analyzer

Coil

Model	3.7L
Coil Part Number	32193A2
Maximum Operating Amperes*	1.1
Primary Resistance*	1.1-1.5 Ohms
Secondary Continuity*	9500-15000 Ohms
Resistor Wire	1.8-2 Ohms

NOTE: * Use magneto analyzer

Spark Plugs

3.7L With Breaker Point Ingition
AC MR43T
Champion RV15YC4
NGK BR6FS

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Distributor Clamp	20	27
Spark Plugs	15	20

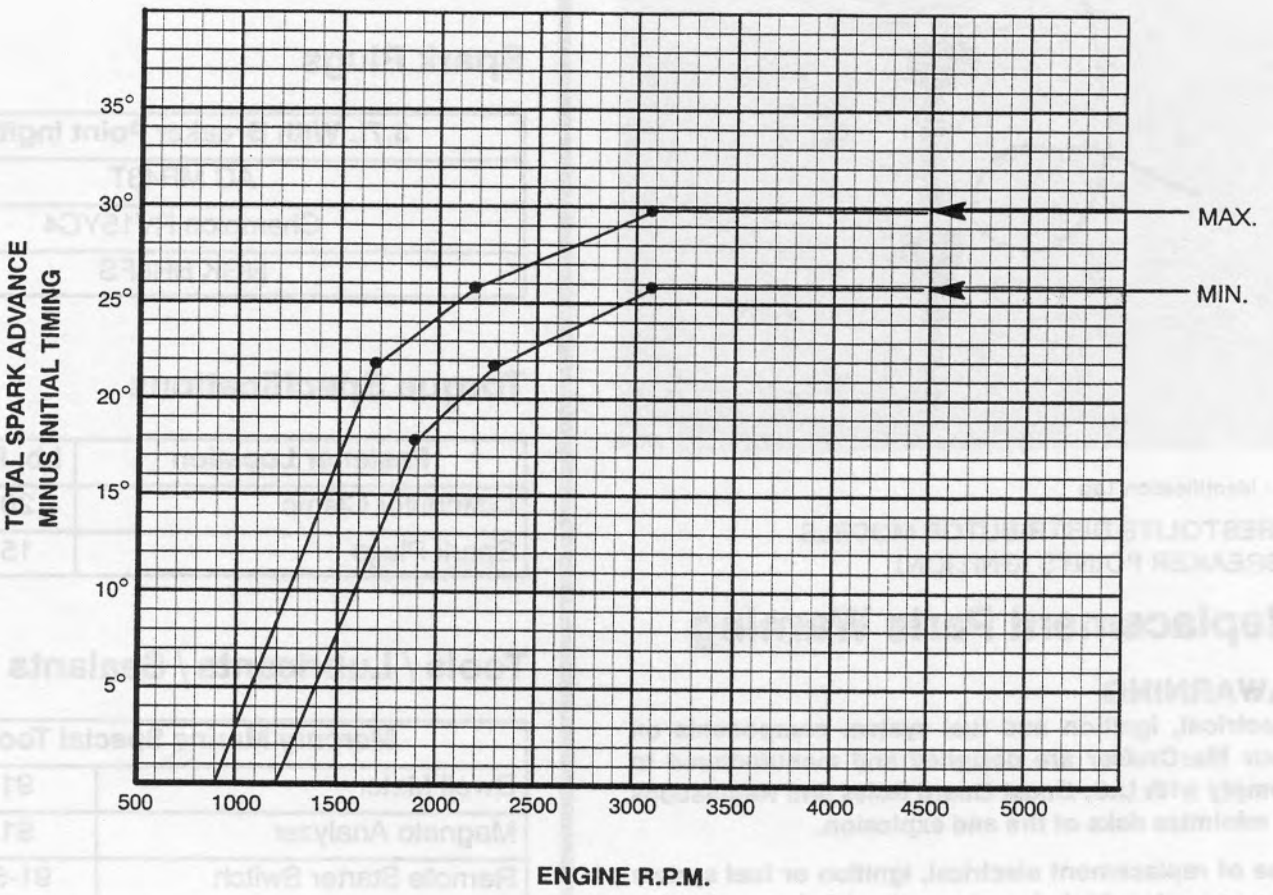
Tools / Lubricants / Sealants

Mercury Marine Special Tools	
Dwell Meter	91-59339
Magneto Analyzer	91-76032
Remote Starter Switch	91-52024A1
Timing Light	91-99379
Volt / Ohm Meter	91-99750
Quicksilver Liquid Neoprene	92-27511-1
Points Spring Tension Guage	Obtain Locally
Distributor Cam Lubricant	

Distributor Advance Curve

MCM 3.7L With Prestolite Distributor (Breaker Point Ignition)

Distributor Advance: 28°
Initial Timing: 4° BDTC
Total Advance: 32° @ 3100 RPM
Point Gap and Dwell: .016 in. (0.5 mm), 39° - 45°



Repair

Precautions

⚠WARNING

When performing the following procedure, be sure to observe the following.

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet, and clothing clear of engine moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (-) ground.**
- **Do not disconnect battery cables while engine is running.**

Distributor Cap and Rotor

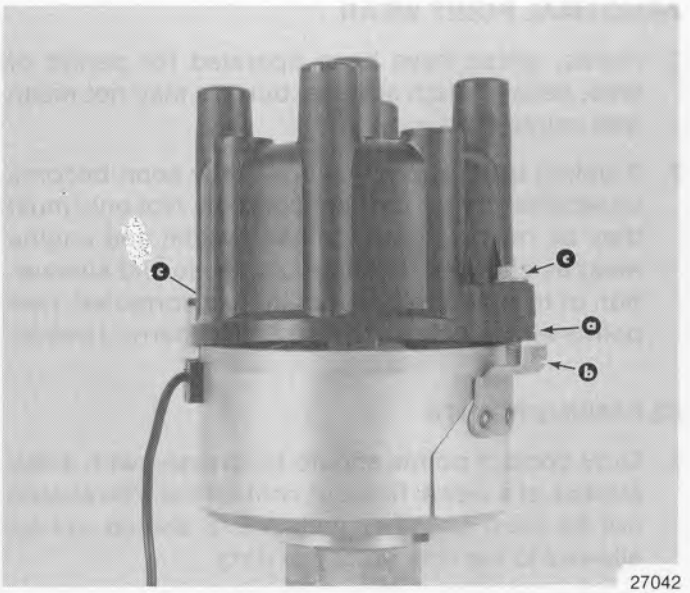
1. Loosen distributor cap retaining screws.
2. Remove distributor cap.

IMPORTANT: If high tension leads are removed from cap, replace in correct firing order.

3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contacts for excessive burning or corrosion. Check center contact for deterioration.

IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

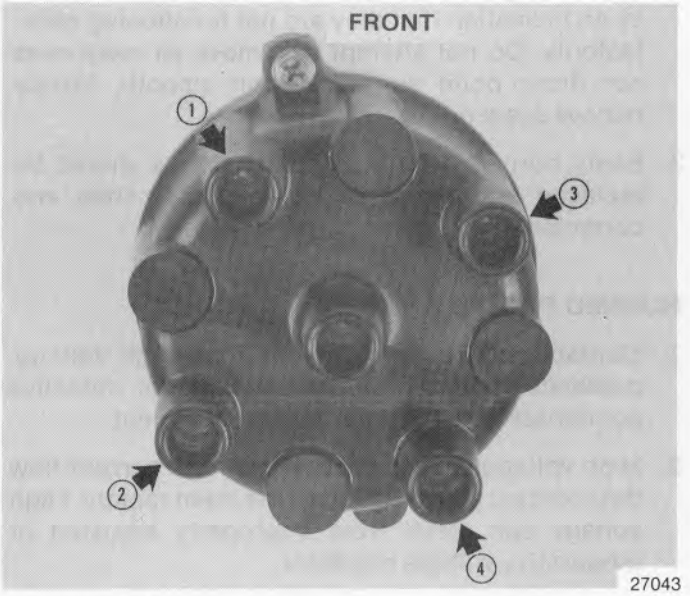
5. Check cap for cracks or carbon tracks using Magneto Analyzer.
6. Remove rotor.
7. Check for burned or corroded center contact.
8. Check rotor for cracks and carbon tracks using Magneto Analyzer.
9. Install rotor on shaft. Be sure rotor is completely seated on shaft.
10. Place cap on distributor.
11. Tighten retaining screws securely.



27042

12. Install spark plug wires (if removed) as shown.

4 CYLINDER DISTRIBUTOR CAP WIRING



27043

Contact Points

1. Examine contact points for dirt, wear, pitting and misalignment. Dirty points should be cleaned. Normal point condition is an overall grey color on contact surface.
2. Check for point resistance. A voltage drop of less than .125 volts across points should exist. Make this check with a sensitive volt meter or point resistance meter.

ABNORMAL POINT WEAR

1. Points, which have been operated for period of time, have a rough surface, but this may not mean that points are worn out.
2. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition is corrected, new points will provide no better service than old points.

CLEANING POINTS

1. Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

IMPORTANT: Never use emery cloth to clean contact points.

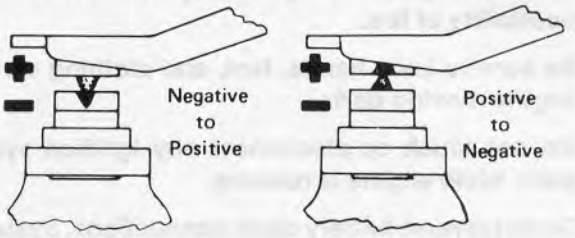
2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

BURNED POINTS

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser and improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly.
4. If contact point opening is too small (cam angle too large), points will be closed too long. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points.
5. High series resistance in condenser circuit will prevent normal condenser action, so contact points will burn rapidly. This resistance may be caused by a loose condenser mounting or lead connection, or by poor connections inside condenser.

PITTED POINTS

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other.



Material Transfer

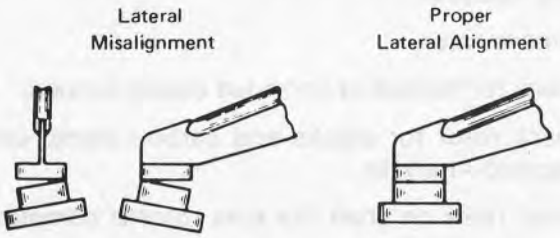
2. If points are pitted, replace condenser (and points).

Replacement

1. Remove primary and condenser lead wires from contact point terminal.
2. Remove contact set attaching screw and lift contact point set from breaker plate.
3. Clean oil smudge and dirt from breaker plate.

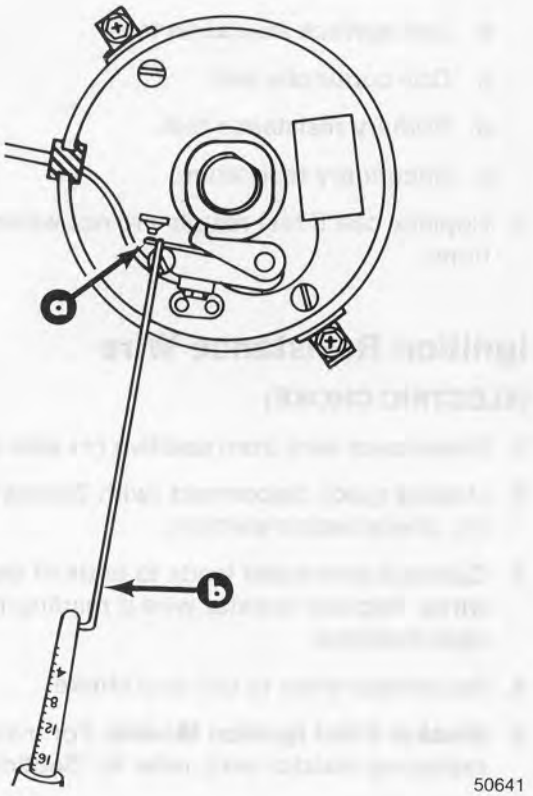
IMPORTANT: Carefully wipe protective film from point set prior to installation.

4. Place a small amount of Distributor Cam Lubricant on distributor cam.
5. Place new contact point assembly in position on breaker plate and install attaching screw.
6. Check points for proper alignment. If points do not align properly, replace with another set of points.



7. Connect primary and condenser lead wires to terminal on contact point set.

8. Check point spring tension (20-27 oz. [567-765g]).



50641

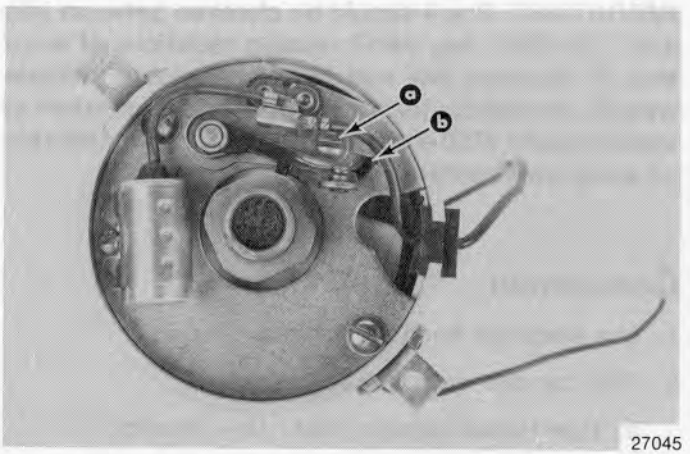
a - Movable Contact
b - Spring Tension Gauge

Contact point pressure must fall within specified limits (Step 8, preceding). Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Contact point pressure should be checked with a spring gauge. Scale should be hooded to breaker lever, and pull exerted at 90° to breaker lever. Reading should be taken just as points separate. Pressure can be adjusted by bending breaker lever spring. If pressure is excessive, it can be decreased by pinching spring carefully. To increase pressure, remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.

IMPORTANT: Point gap or (dwell) can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter. Points, however, also can be adjusted, as well as checked, with a dwell meter: After points have been set, dwell should be checked with engine running.

POINT ADJUSTMENT WITH FEELER GAUGES

1. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
2. Insert correct feeler gauge between breaker points.
3. Loosen lock screw and adjust points to .016 in. (0.5mm).



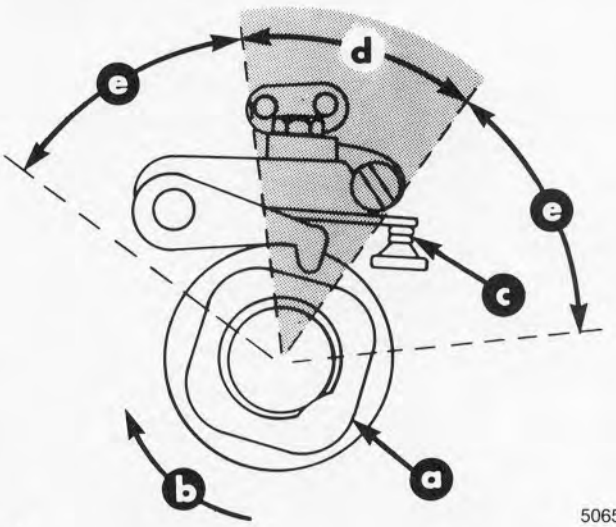
27045

a - Lock Screw
b - Adjustment Slot

DWELL ADJUSTMENT

1. Remove distributor cap and rotor.
2. Connect positive (+) dwell meter lead to negative (-) side of coil. Connect negative (-) meter lead to ground.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver to obtain reading on dwell meter, as specified in "Specifications", and tighten lock screw. (Dwell reading will be unsteady using this method.)

IMPORTANT: Cam angle increases as point opening is decreased and vice versa.



50654

a - Cam
b - Direction of Rotation
c - Breaker Points
d - Dwell (in degrees [Points are Closed])
e - Points Open

Cam Angle

5. Install rotor and distributor cap and recheck dwell with engine running.

IMPORTANT: Dwell should be checked between idle and 1750 RPM. Any dwell reading variations of more than 3° between idle and 1750 RPM would indicate wear in the distributor. Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some dwell meters.

Condenser

1. Use Magneto Analyzer for test.
2. Test condenser for the following:
   a. Condenser capacity test (.18 - .25 mfd).
   b. Condenser leakage and short test.
   c. Condenser series resistance test.
3. Replace condenser if test results are not within specifications.

Coil

1. Use Magneto Analyzer for test.
2. Check coil for the following:
   a. Coil power test.
   b. Coil surface insulation test.
   c. Coil continuity test.
   d. Primary resistance test.
   e. Secondary resistance.
3. Replace coil if test results are not within specifications.

Ignition Resistance Wire

(ELECTRIC CHOKE)

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wires. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. **Breaker Point Ignition Models:** For instructions on replacing resistor wire, refer to "Section 4, Part E".

Distributor Repair

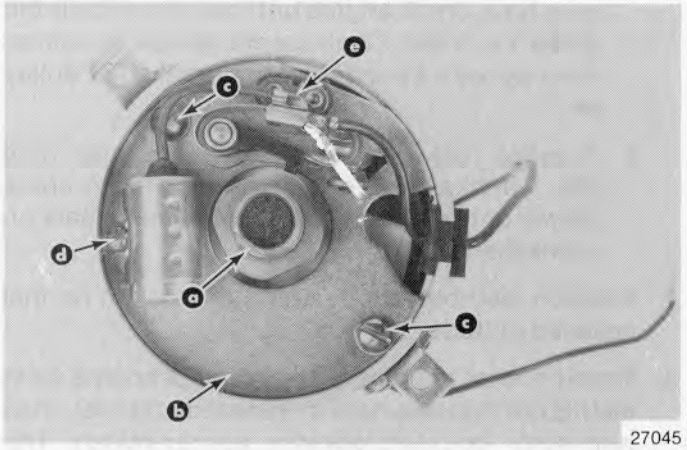
Removal

1. Disconnect distributor primary lead from coil terminal.
2. Remove distributor cap and rotor.

IMPORTANT: If necessary to remove leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.

3. Scratch a realignment mark on distributor in line with rotor notch (located on distributor shaft).
4. Mark distributor housing in relation to engine block for ease in installation.
5. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation.

IMPORTANT: Avoid rotating engine with distributor removed, as ignition timing will be upset.



27045

a - Rotor Alignment "Flat"
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Condenser Bracket w/Screw
e - Wire Terminal w/Screw

Breaker Plate and Attacking Parts

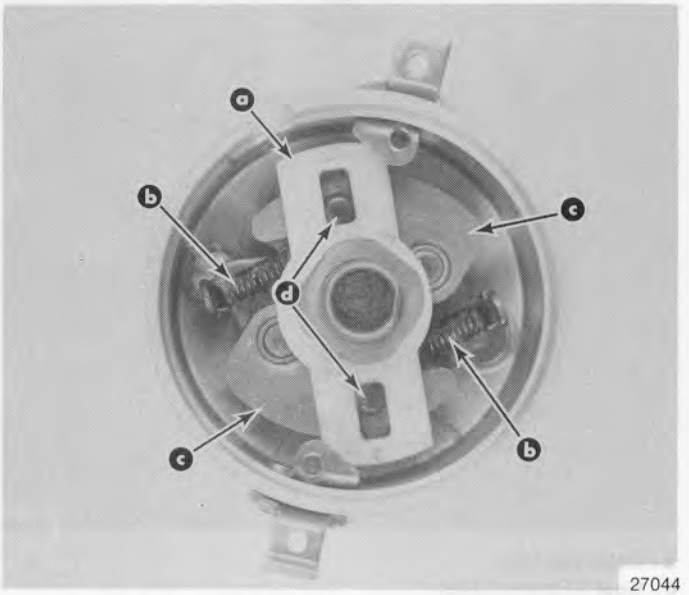
Disassembly

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Remove condenser and breaker points from breaker plate. Test condenser and check breaker points.
2. Remove breaker plate from distributor housing. Excessive oil on breaker plate assembly would indicate a bad oil seal in distributor housing.

IMPORTANT: Main shaft bushings and oil seal in housing are not serviced separately. Housing, bushings and oil seal are serviced as complete assembly.

3. Remove roll pin retaining driven gear to main shaft and slide gear from shaft.
4. Check for side play between main shaft and bushings in distributor housing. Maximum side play allowed is .002 in. (0.05mm).
5. Remove main shaft from housing and inspect for worn cam lobes. Check shaft for being bent by placing in v-blocks and checking run out with a dial indicator. Maximum run out allowed is .002 in. (0.05mm).
6. Remove weight cover, check weights and weight stop for wear. Check weights for free movement on pins.



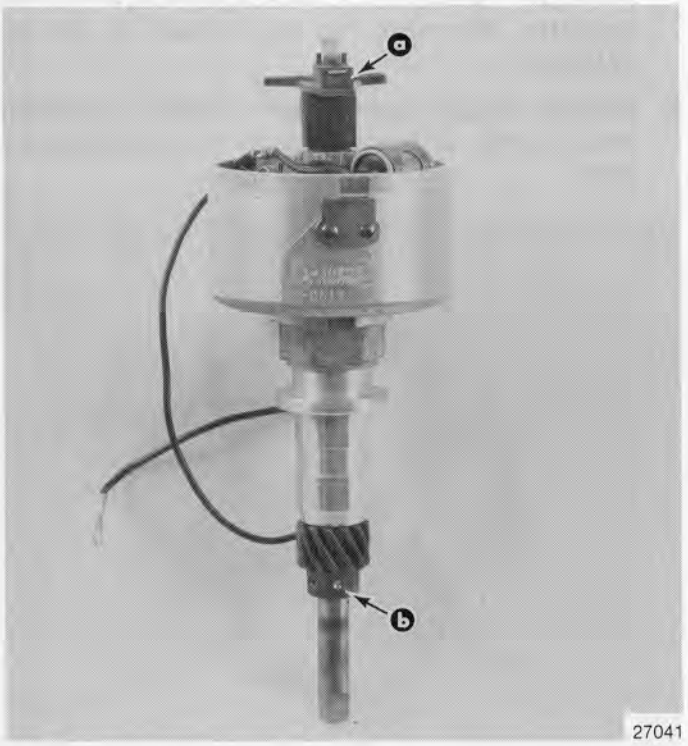
27044

a - Weight Cover
b - Weight Springs
c - Weights
d - Weight Stop Studs

Advance Weights and Components

Reassembly

1. Replace centrifugal advance, as necessary.
2. Lubricate main shaft with engine oil and install in distributor housing.
3. Install driven gear on main shaft.
4. Line up mark on driven gear with rotor tip on main shaft.
5. Install roll pin through gear and main shaft.
6. Install breaker plate on distributor housing.
7. Install condenser and breaker points on breaker plate.
8. Install rotor.
9. Install distributor as outlined in "Distributor Installation", following.



a - Rotor Contact
b - Gear Alignment Mark

Gear Installation

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Firing order is 1-3-4-2.

5. Set point gap to .016 in. (0.5mm).
6. Install rotor and cap.
7. Check dwell (39° - 45°).
8. Time ignition as outlined under "Ignition Timing".

Engine Disturbed

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or. . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more toward left and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged, Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Firing order is 1-3-4-2.
8. Set point gap (.016 in. [0.5mm]).
9. Check dwell (39° - 45°).
10. Time ignition as outlined under "Ignition Timing".

Ignition Timing

IMPORTANT: Dwell must be set to specification before adjusting timing.

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications" for cylinder numbering and location.
2. Connect tachometer to engine.

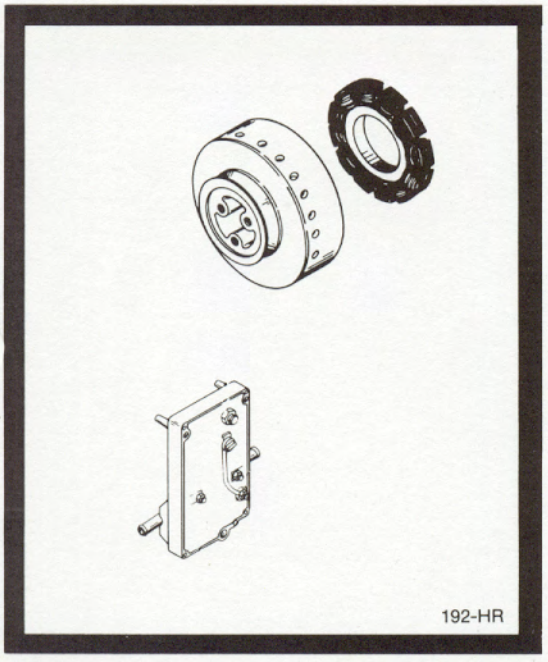
⚠CAUTION

If the following procedure is performed out of water, a water source must be supplied to the water intake openings in gear housing.

3. Start engine and run at normal idle speed.
4. Aim timing light at timing marks as shown.
5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab. Torque clamp bolt to 20 lb. ft. (27 N.m), and recheck location of timing mark.
6. Stop engine and disconnect timing light.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. Timing must be set on the "BEFORE" (Advance) side of "0" (Top Dead Center).

ELECTRICAL SYSTEMS



4

C

CHARGING SYSTEMS

mercruiser
STERN DRIVES & INBOARDS

INDEX

Page

CHARGING SYSTEM
Specifications 4C-1
Torque Specifications 4C-1
Tools/Sealants 4C-1
Description 4C-1
Replacement Parts Warning 4C-1
Precautions 4C-2
Periodic Maintenance 4C-2
Diagnosis 4C-2
  Constant High Output 4C-3
  No Output 4C-3
  Voltage Regulator Test 4C-4
Removal/Installation 4C-5

BATTERY ISOLATORS
Dual Battery Charging Systems
  Using a Battery Isolator 4C-6
System Components 4C-7

Specifications

Model	Amp Output (Max.)	Rotation
MCM 170/190	39	Bi-Rotational

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Hose Clamps	Securely	
Rotor	75 (102)	
Stator		45 (5)
Voltage Regulator (Bolts)	Securely	
Voltage Reguator (Nuts)	Securely	

Tools/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-99750	Volt/Ohm Meter

KENT-MORE SPECIAL TOOLS	
Can be ordered from:	Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500
J-21058-20	Rotor Installation Tool
J-6978-04	Rotor Removal Tool

TOOLS PURCHASED LOCALLY
Ammeter (0-50 Amps)

SEALANTS	
92-25711-2	Quicksilver Liquid Neoprene
92-823089-1	Quicksilver Loctite 8831

Description

The electrical generating position of this charging system is quite simple. It consists of six large permanent magnets (rotor), which are rotated by the crankshaft and move past a stationary iron lamination assembly wound with a single phase winding (stator).

The complexity of this charging system is in the regulation of this output. Since the permanent magnets are always turned "full on", the output of the winding is also always at full potential.

This differs from the automotive type where the output can easily be varied by controlling the strength of the rotating electromagnet. The regulator controls output by momentarily and completely disconnecting the output winding from the battery when the regulator senses that the battery is at its correct voltage. The disconnect periods are very short with frequency and duration dependent upon the needs of the battery. This disconnecting of the windings is done thru the use of a pair of silicon control rectifiers in the full wave rectifying bridge of the regulator. The regulators control of this on-off switching is programmed so that no electrical noise, output interruptions, or pulsing of the output current is detectable.

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Precautions

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the charging system.
2. DO NOT short across or ground any of the terminals on the regulator, except as specifically instructed in the "Troubleshooting Tests".
3. NEVER disconnect the regulator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used. BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connections.
2. Check wiring for frayed or worn insulation.

Diagnosis

⚠WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of a fire.**
- **Before connecting or disconnecting any electrical connection, battery cables MUST BE REMOVED from battery to prevent possible personal injury or damage to equipment.**

A. The charging system may be connected to one or more batteries during these tests, however, these batteries must not be connected to any other charging source.

B. Check that all connections are tight prior to starting tests. Insure that the battery posts and terminals are clean and making good contact. Verify with test equipment that wiring harnesses are not at fault.

C. Examine the pins and sockets of the engine harness connector for burned, loose or dirty connections. Using a knife blade, spread the slot (in the male pins of this connector) slightly to insure good contact.

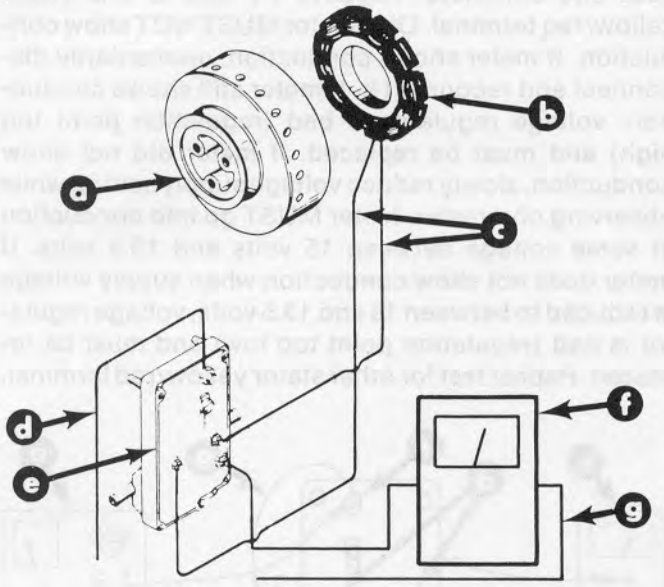
D. Make sure alternator rotor is magnetized.

⚠WARNING

All engines are wired for voltmeters. Ammeters should not be used. Excessive resistance in the ammeter circuit can cause voltage regulator damage.

IMPORTANT: Temporarily install ammeter in series with the orange (red/white) output lead from the regulator. This meter is required only for these tests, following:

CONSTANT HIGH OUTPUT

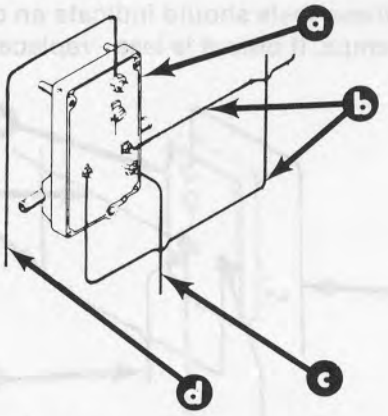


a - Rotor
b - Stator
c - Stator Wires - Yellow/Red
d - Sensing Wire - Red/Purple (Red)
e - Voltage Regulator
f - Test Ammeter (0-50 Amps)
g - Output Wire - Orange (Red/White)

1. Remove one yellow-red wire from its regulator terminal and tape back temporarily. Run engine at 1000 RPM. Any output current indicates a stator short to ground.
2. Reconnect the yellow-red lead and repeat test with the other yellow-red lead.
3. If there is no output with either yellow-red lead in the above test, the regulator is bad.

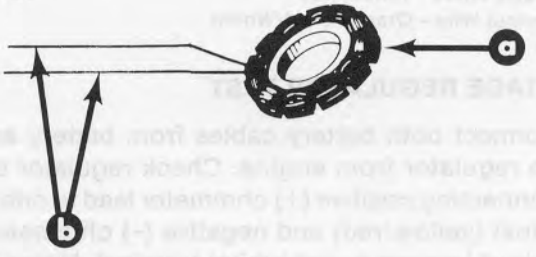
NO OUTPUT

1. Remove the 2 yellow/red and the orange (red/white) leads from the regulator.
2. Check the resistance between the regulator case and either yellow/red stud. A near zero reading from either stud to the case indicates a bad regulator.



a - Voltage Regulator
b - Stator Wires - Yellow/Red Disconnect
c - Output Wire - Orange (Red/White) Disconnect
d - Sensing Wire - Red/Purple (Red)

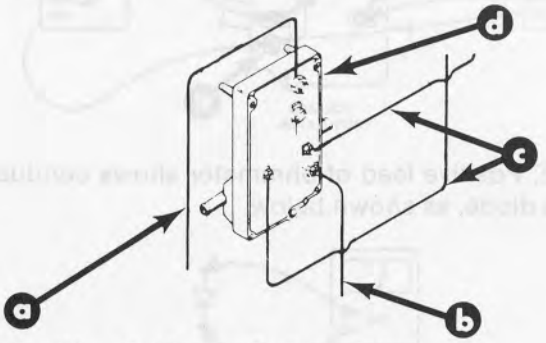
3. Check the resistance between the yellow/red leads. Resistance greater than 1 ohm indicates a bad stator.



a - Stator
b - Stator Wires - Yellow/Red

If Steps 2 and 3 tests show both parts to be good, proceed.

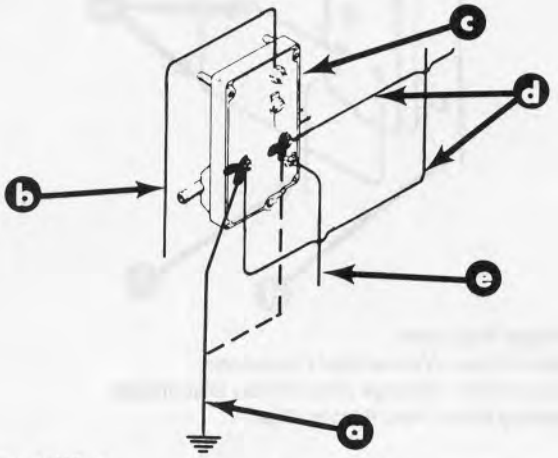
4. With all leads on the regulator, except the sense lead, run the engine at 1000 RPM and observe ammeter. Any charging current indicates a low voltage set point - replace regulator.



a - Sensing Wire - Red/Purple (Red) Disconnect
b - Output Wire - Orange (Red/White)
c - Stator Wires - Yellow/Red
d - Voltage Regulator

If there isn't any output, proceed.

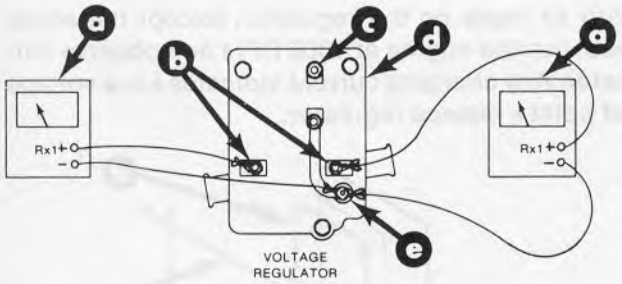
5. With all leads reconnected, use a jumper lead (with "alligator clips" at both ends). Clip one end of jumper lead to ground and the other end of the lead to one yellow-red terminal (on regulator). Run the engine at 1000 RPM and observe ammeter. Repeat this same test with the other yellow-red terminal. Both of these tests should indicate an output of at least 10 amps. If output is less - replace regulator.



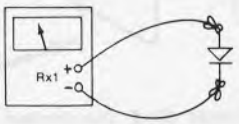
a - Jumper Wire
b - Sensing Wire - Red/Purple (Red)
c - Voltage Regulator
d - Stator Wires - Yellow/Red
e - Output Wire - Orange (Red/White)

VOLTAGE REGULATOR TEST

Disconnect both battery cables from battery and remove regulator from engine. Check regulator diodes by connecting positive (+) ohmmeter lead to one stator terminal (yellow/red) and negative (-) ohmmeter lead to output (orange or red/white) terminal. Meter MUST show conduction. Reverse ohmmeter leads. Meter MUST NOT show conduction. Repeat test for other stator (yellow/red) terminal.

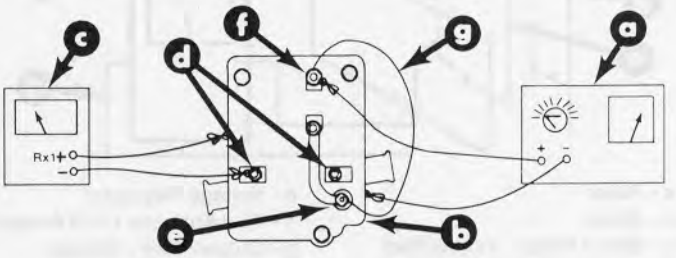


NOTE: Positive lead of ohmmeter shows conduction with a diode, as shown below.



a - Ohmmeter
b - Yellow/Red Terminals
c - Red/Purple (Red) Terminal
d - Voltage Regulator
e - Orange (Red/White) Terminal

Check voltage regulation point using D.C. variable voltage supply and ohmmeter. Connect voltage supply positive (+) lead to sense terminal. Connect jumper wire from sense terminal to output terminal. Connect voltage supply negative (-) lead to ground on regulator ease. Turn on voltage supply to 16-18 volts. Connect ohmmeter positive (+) lead to ground on regulator case and ohmmeter negative (-) lead to one stator yellow/red terminal. Ohmmeter MUST NOT show conduction. If meter shows conduction, momentarily disconnect and reconnect it. If meter still shows conduction, voltage regulator is bad (regulation point too high) and must be replaced. If meter did not show conduction, slowly reduce voltage supply setting while observing ohmmeter. Meter MUST go into conduction at some voltage between 15 volts and 13.5 volts. If meter does not show conduction when supply voltage is reduced to between 15 and 13.5 volts, voltage regulator is bad (regulation point too low) and must be replaced. Repeat test for other stator yellow/red terminal.

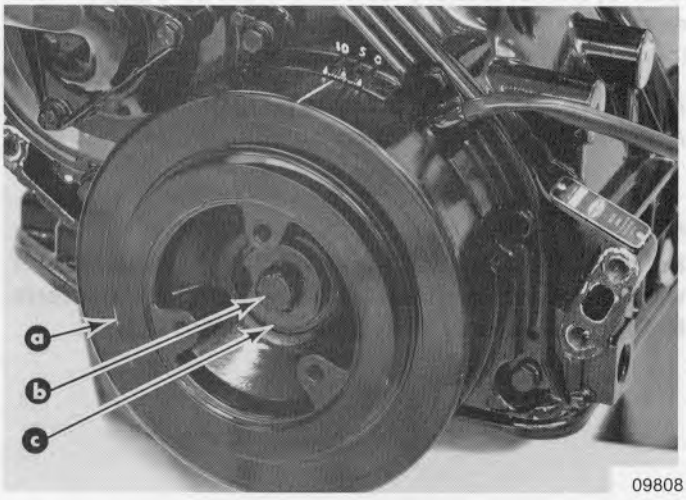


a - D.C. Variable Voltage Supply
b - Voltage Regulator
c - Ohmmeter
d - Yellow/Red Terminal
e - Output Terminal
f - Sense Terminal
g - Jumper Wire

Removal/Installation Alternator Rotor

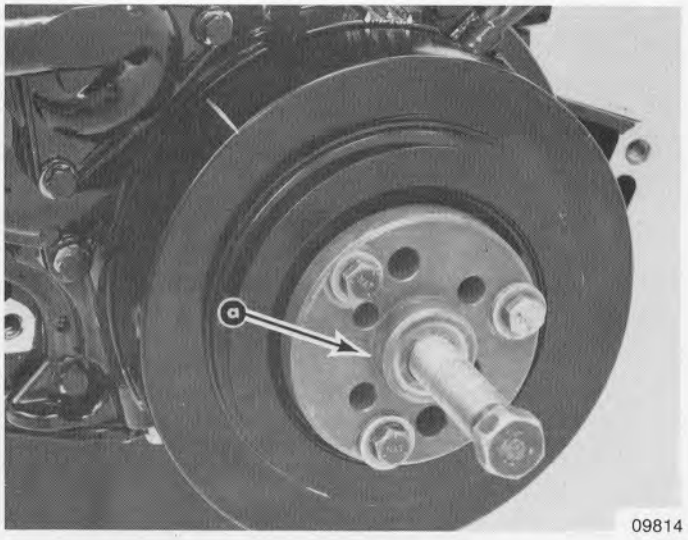
REMOVAL

1. Remove front engine mount assembly (if applicable).
2. Remove bolt from center of rotor and remove washer from bolt.
3. Install Tool J-6978-04 and remove rotor assembly. Use grease on tapered end of tool.
4. Measure oil seal area with micrometer, for undersize (see "Specifications").



09808

a - Alternator Rotor
b - Center Bolt
c - Washer



09814

a - J-6978-04 Tool

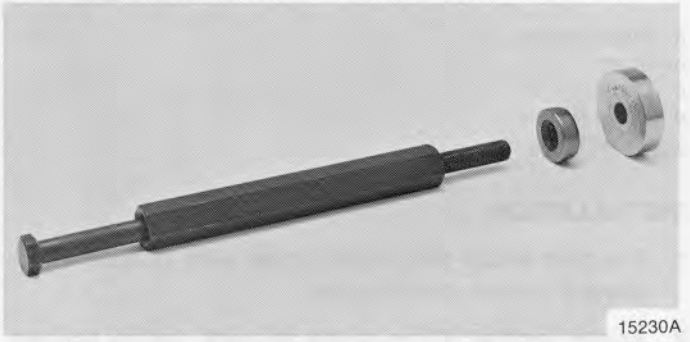
INSTALLATION

1. Lubricate lip of oil seal and rotor surface (where oil seal rides) with engine oil.
2. Check that rotor locating key is properly installed in crankshaft groove.
3. Lubricate crankshaft end and inside diameter of rotor assembly with Chicago Manufacturing and Distribution Co. anti-scoring, extreme pressure Lubricant No. 3 or equivalent.
4. Position rotor assembly onto crankshaft, aligning key slot in rotor with key located on crankshaft.
5. Install Tool J-21058-20 into crankshaft end. Hold tool center shaft from turning and turn large nut to install rotor until rotor bottoms out.

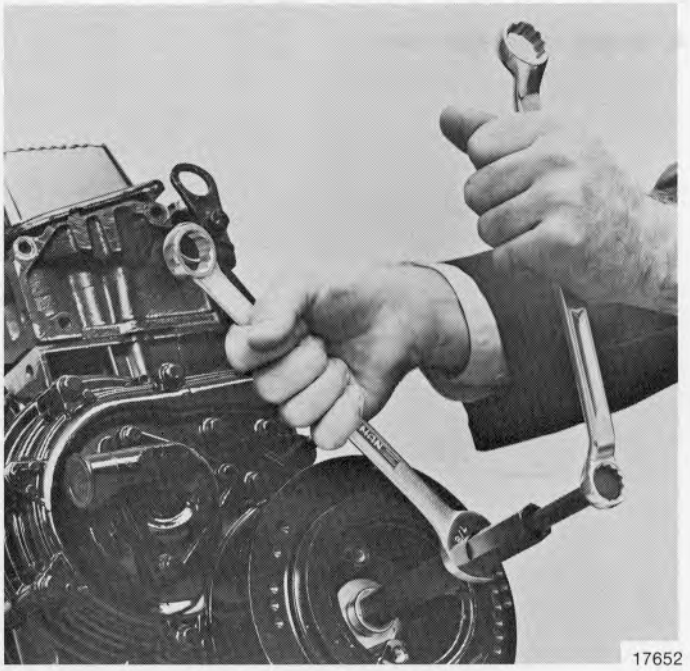
⚠CAUTION

DO NOT use hammer to drive rotor on, as this can loosen magnets in rotor.

6. Install rotor fastening bolt and washer and torque bolt to specifications.


15230A

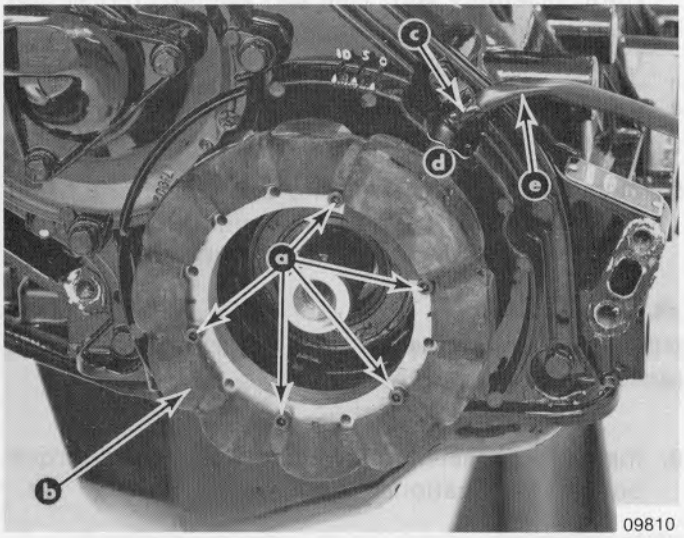
J-21058-20 Tool


17652

Stator

REMOVAL

1. Remove alternator rotor.
2. Disconnect stator wires from regulator.
3. Remove stator fastening screws and remove stator.



a - Stator Screws
b - Stator
c - Clamp
d - Cover Recess
e - Stator Wires

INSTALLATION

1. Position stator onto front cover with output wires toward recess cast in cover.
2. Apply Loctite "A" on screw threads, install screws and torque to specifications.
3. Reconnect stator wires to regulator.
4. Install alternator rotor.

Battery Isolators

DUAL BATTERY CHARGING SYSTEMS USING A BATTERY ISOLATOR

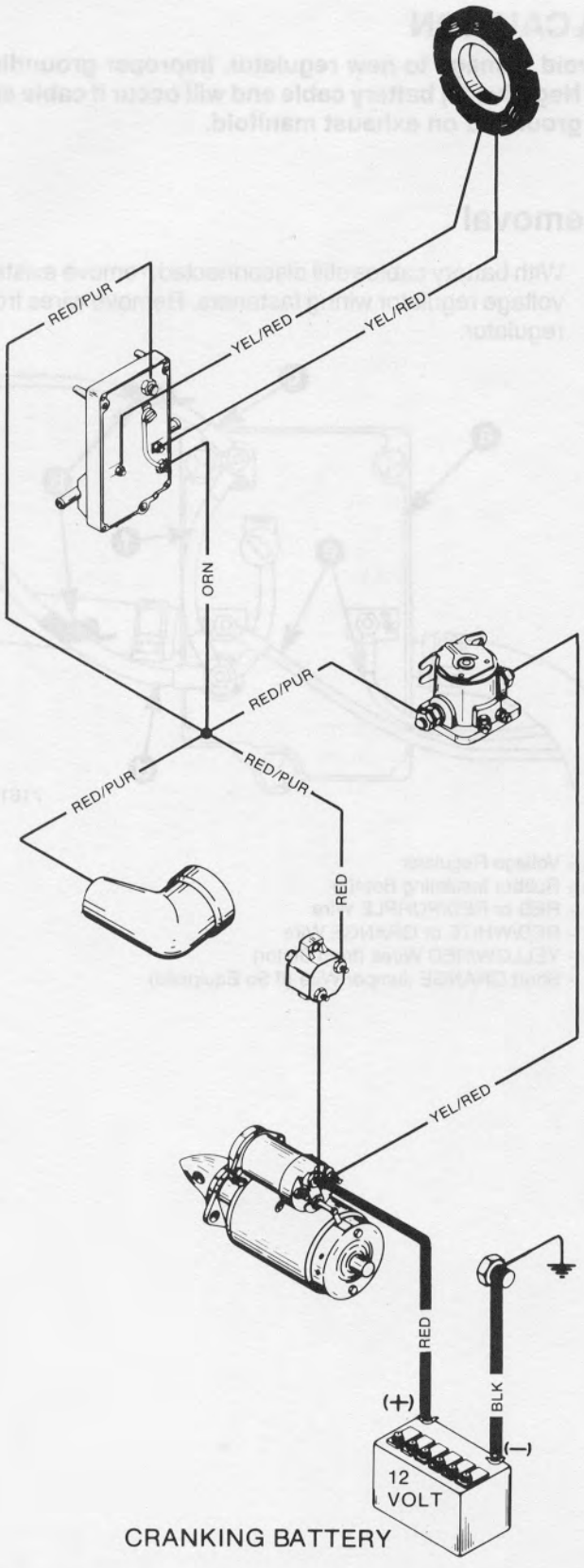
Battery isolators allow the addition of an auxiliary (second) battery to the MerCruiser electrical system, the auxiliary battery is primarily used as a power source for various accessories installed on the boat. The battery isolator will allow the alternator to charge both the cranking and auxiliary batteries at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

Mercury Marine does not manufacture any battery isolator systems. Battery isolators must be bought from an outside manufacturer. Mercury Marine suggests following the manufacturers instruction carefully.

IMPORTANT: Alternators used on MerCruiser engines ARE NOT equipped with an isolation diode.

⚠ CAUTION

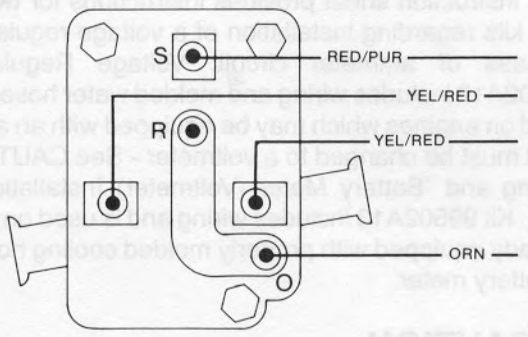
Follow battery isolator manufacturer's instructions for wire gauge. Battery isolator installation must conform to BIA Low Voltage Wiring Standard No. 125-79.



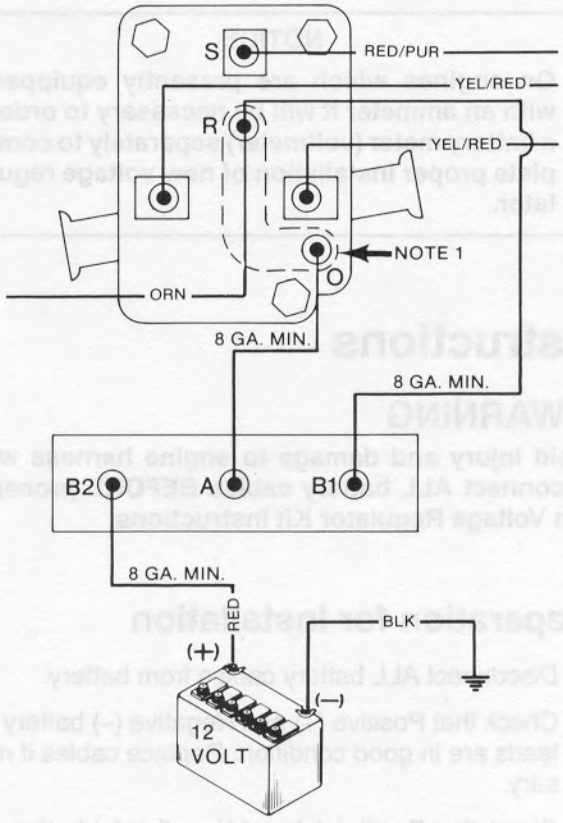
CRANKING BATTERY

Charging System Components

Original Wiring



Wiring Connections with Isolator



AUXILIARY BATTERY

BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

NOTE 1. REMOVE METAL JUMPER AND DISCARD.

99502A12 and 99502A13 Voltage Regulator Kit

This instruction sheet provides instructions for two separate kits regarding installation of a voltage regulator, and by-pass of ammeter circuit. Voltage Regulator Kit 99502A12 includes wiring and molded water hoses, and is used on engines which may be equipped with an ammeter [that must be changed to a voltmeter - See CAUTION following and "Battery Meter (Voltmeter) Installation" section]. Kit 99502A13 includes wiring and is used on engines already equipped with properly molded cooling hoses and a battery meter.

⚠ CAUTION

Excessive resistance in the ammeter circuit (from regulator to ammeter and returning to battery) could cause voltage regulator to malfunction. To eliminate this potential problem, it is necessary to by-pass the ammeter circuit and to replace ammeter in the dash with a battery meter (voltmeter).

NOTICE

On engines which are presently equipped with an ammeter it will be necessary to order a battery meter (voltmeter) separately to complete proper installation of new voltage regulator.

Instructions

⚠ WARNING

Avoid injury and damage to engine harness wiring. Disconnect ALL battery cables BEFORE proceeding with Voltage Regulator Kit instructions.

Preparation for Installation

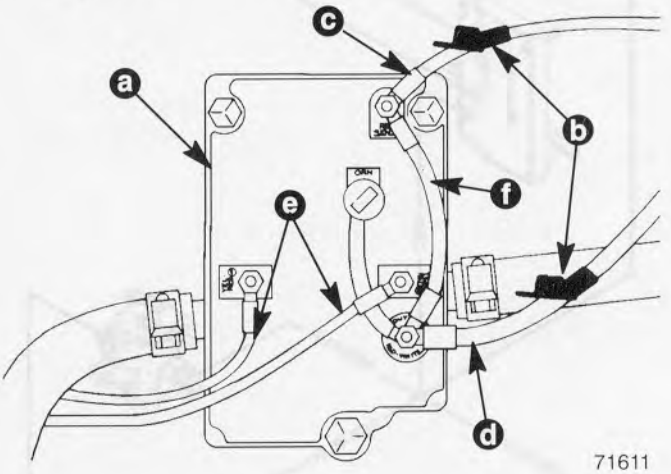
1. Disconnect ALL battery cables from battery.
2. Check that Positive (+) and Negative (-) battery cable leads are in good condition. Replace cables if necessary.
3. Check that Positive (+) and Negative (-) battery cable terminal ends, terminal end clamps at battery, and connections at engine are in good condition. Replace terminal ends or cables as necessary.
4. Check that Negative (-) battery cable terminal end at engine is attached to a clean, unpainted surface to assure metal-to-metal contact on engine grounding stud or at back of cylinder head.

⚠ CAUTION

Avoid damage to new regulator. Improper grounding of Negative (-) battery cable end will occur if cable end is grounded on exhaust manifold.

Removal

1. With battery cables still disconnected, remove existing voltage regulator wiring fasteners. Remove wires from regulator.



a - Voltage Regulator
b - Rubber Insulating Boot(s)
c - RED or RED/PURPLE Wire
d - RED/WHITE or ORANGE Wire
e - YELLOW/RED Wires (from Stator)
f - Short ORANGE Jumper Wire (If So Equipped)

2. Follow instructions "a" or "b":

   a. **When installing Voltage Regulator Kit 99502 A13:**

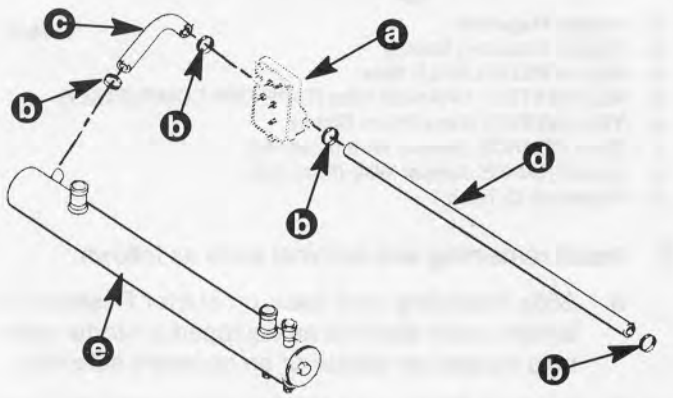
      (1.) Loosen hose clamps on cooling hoses at voltage regulator.

      (2.) Disconnect cooling hoses.

   b. **When installing Voltage Regulator Kit 99502 A12:**

      (1.) Loosen hose clamps and disconnect cooling hoses from voltage regulator.

      (2.) Loosen hose clamp at heat exchanger and seawater inlet. Remove hoses.



71612

a - Voltage Regulator
b - Hose Clamp(s)
c - Cooling Hose, Voltage Regulator-to-Heat Exchanger
d - Cooling Hose, Seawater Inlet-to-Voltage Regulator
e - Heat Exchanger

3. Remove the three fasteners retaining voltage regulator. Remove and discard regulator.

Cleaning and Inspection

Prior to mounting new regulator from kit:

1. **Inspect Engine Block (where regulator mounts).** Be certain the area is:
   a. Clean.
   b. Unpainted (to assure metal-to-metal contact).
   c. No corrosion is present.
2. **Inspect new Voltage Regulator.** Be certain front and rear of mounting bosses are:
   a. Clean.
   b. Unpainted (to assure metal-to-metal contact).
   c. No corrosion is present.
3. Clean corrosion or paint from fasteners.

Installation

1. After cleaning and inspection as previously outlined, install new regulator using existing fasteners. Tighten fasteners securely.
2. Follow instructions "a" or "b":

   a. **When installing Voltage Regulator Kit 99502 A13:**

      (1.) Reconnect cooling hoses. Tighten hose clamps securely.

      (2.) Connect RED or RED/PURPLE wire to "Sense" (upper) terminal. Tighten fastener securely.

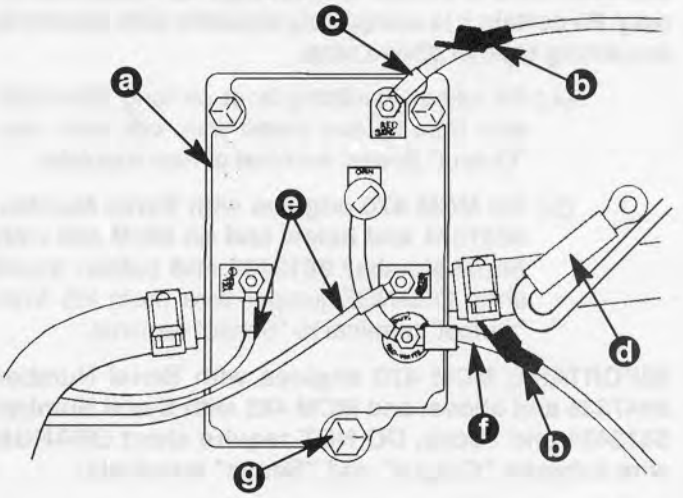
      (3.) Connect YELLOW or YELLOW/RED wires from stator to terminals on regulator, as shown. Tighten fasteners securely.

      (4.) Remove rubber insulating boot (retain) and bend back and tape-off RED/WHITE or ORANGE wire that was formerly attached to "Output" (lower) terminal of regulator. Tape wire back to itself to avoid contact with other wires.

IMPORTANT: In following view RED/WHITE or ORANGE wire is shown without tape for visual clarity only. Be certain it is completely covered with at least 4 layers of electrical insulating tape in above step.

      (5.) Fit rubber insulating boot on long ORANGE wire from kit and install wire with boot onto "Output" (lower) terminal of new regulator.

      (6.) Install retaining nut on "Output" terminal after making connections as outlined above. Tighten securely.

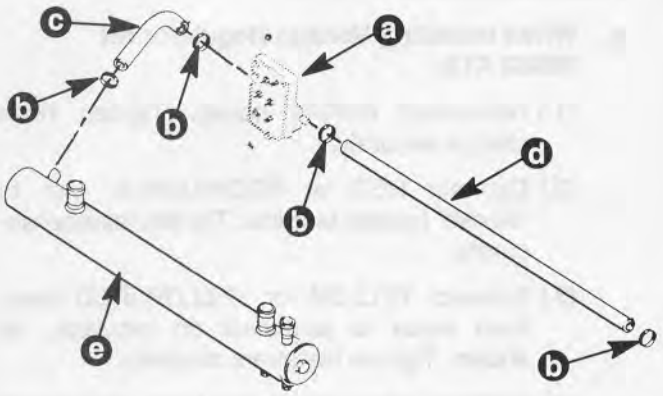


71618

a - Voltage Regulator
b - Rubber Insulating Boot(s)
c - RED or RED/PURPLE Wire
d - RED/WHITE or ORANGE Wire (TAPE-OFF COMPLETELY)
e - YELLOW/RED Wires (from Stator)
f - Long ORANGE Jumper Wire (From Kit)
g - Fastener(s) (3 Total)

b. **When installing Voltage Regulator Kit 99502 A12:**

(1.) Install cooling hoses from kit between heat exchanger, seawater inlet, and regulator. Tighten hose clamps securely.



71612

a - Voltage Regulator
b - Hose Clamp(s)
c - Cooling Hose, Voltage Regulator-to-Heat Exchanger (From Kit)
d - Cooling Hose, Seawater Inlet-to-Voltage Regulator (From Kit)
e - Heat Exchanger

(2.) Connect YELLOW or YELLOW/RED wires from stator to terminals on regulator, as shown. Tighten fasteners securely.

(3.) Remove rubber insulating boot and tape-off and bend back RED/WHITE or ORANGE wire that was formerly attached to "Output" (lower) terminal of regulator. Tape wire back to itself to avoid contact with other wires.

IMPORTANT: In following view RED/WHITE or ORANGE wire is shown without tape for visual clarity only. Be certain it is completely covered with electrical insulating tape in above step.

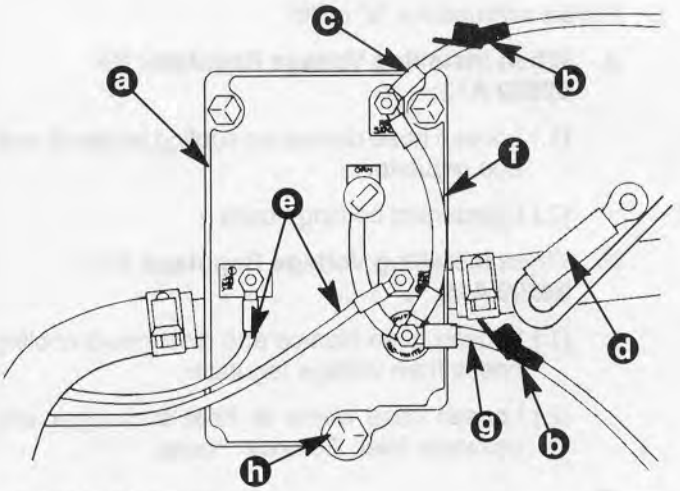
(4.) Fit rubber insulating boot on long ORANGE wire from kit and install wire with boot onto "Output" (lower) terminal of new regulator.

(5.) **On MCM 470 engines with Serial Number 5847334 and below and on MCM 485 with Serial Number 5813433 and below:** Install short ORANGE jumper wire (from kit) from "Output" terminal to "Sense" terminal.

IMPORTANT: MCM 470 engines with Serial Number 5847335 and above, and MCM 485 with Serial Number 5813434 and above, DO NOT require short ORANGE wire between "Output" and "Sense" terminals.

(6.) Connect RED or RED/PURPLE wire to "Sense" (upper) terminal. Tighten fastener securely.

(7.) Install retaining nut on "Output" (lower) terminal after making connections as outlined above. Tighten securely.



71619

a - Voltage Regulator
b - Rubber Insulating Boot(s)
c - RED or RED/PURPLE Wire
d - RED/WHITE or ORANGE Wire (TAPE-OFF COMPLETELY)
e - YELLOW/RED Wires (From Stator)
f - Short ORANGE Jumper Wire (From Kit)
g - Long ORANGE Jumper Wire (From Kit)
h - Fasteners (3 Total)

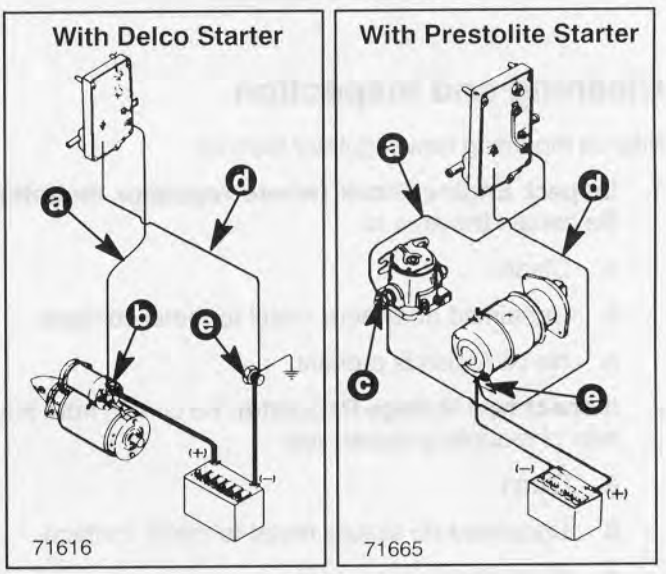
3. Install remaining wire terminal ends as follows:

   a. Slide insulating boot back on starter Positive (+) battery cable terminal as equipped at starter solenoid located on starter or on separate solenoid.

   b. Remove Positive (+) (RED) battery cable terminal end retaining nut and add terminal end of long ORANGE jumper wire (from kit) to connection.

   c. Install retaining nut and tighten securely.

   d. Remove Negative (–) (BLACK) battery cable retaining fastener where grounded on engine and add voltage regulator BLACK ground (–) wire terminal end to connection. Install retaining fastener and tighten securely.



a - Long ORANGE Jumper Wire (from kit)
b - Positive (+) Battery Cable Terminal At Solenoid on Starter
c - Positive (+) Battery Cable Terminal At Separate Solenoid
d - Voltage Regulator Negative [ground (–)] Wire Terminal End
e - Negative (–) Battery Cable Terminal End at Engine Ground (–)

4. Coat all connections at new voltage regulator and at starter terminal with Liquid Neoprene (Quicksilver Part Number 92-25711-1). Slide rubber insulating boots into position over "Sense" and "Output" terminals at regulator and on Positive (+) battery cable terminal end at starter solenoid.
5. Follow instructions "a" or "b":
   a. **When installing Voltage Regulator Kit 99502 A12:** Proceed to "Battery Meter (Voltmeter) Installation" section.
   b. **When installing Voltage Regulator Kit 99502 A13:** Proceed to "Completing Installation" section.

Battery Meter (Voltmeter) Installation

1. With battery cables still disconnected, remove existing ammeter from dash.
2. Install battery meter (voltmeter) into dash in accordance with instructions provided with gauge.

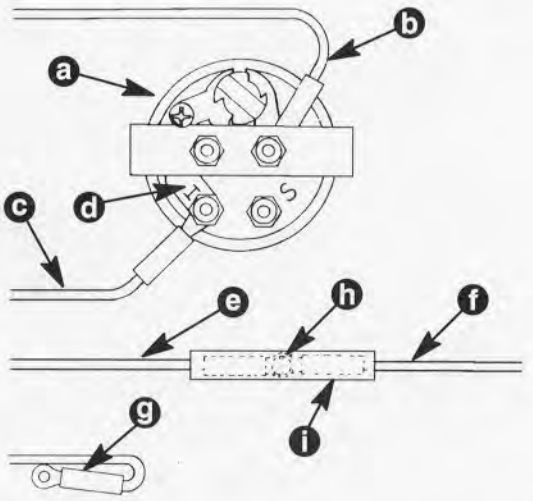
⚠CAUTION

Avoid improper wiring connections on battery meter. Hex nuts are provided in kit for connecting wires. DO NOT remove hex nuts which are already fastened on battery meter terminals, with the exception of when a separate switch (other than ignition switch) is to be used for dash lights.

3. Follow instructions "a" or "b":
   a. **If ignition switch is to be used for dash lights:** Proceed to step 4.
   b. **If a separate switch (other than ignition switch) is to be used for dash lights:**
      (1.) Remove and retain hex nut and screw, which secure metal link to "I" terminal and light bulb socket.
      (2.) Remove link.
      (3.) Reinstall hex nut on terminal "I" and connect dash light wire (from separate switch) to light bulb socket terminal with screw.
4. Connect BLACK wire (disconnected from ammeter) to "G" (ground) terminal on battery meter.
5. Connect WHITE or PURPLE wire (disconnected from ammeter) to "I" (ignition) terminal on battery meter.

IMPORTANT: If ammeter did not have a WHITE or PURPLE wire lead connected to it, use a PURPLE jumper wire and connect "I" terminal on battery meter to "I" terminal on water temperature gauge or oil pressure gauge.

6. Coat all electrical connections with Liquid Neoprene.
7. Connect RED or RED/PURPLE wire (disconnected from ammeter) to RED/WHITE or ORANGE *ignition switch* wire (disconnected from ammeter) with screw, hex nut and rubber sleeve. Coat connection with Liquid Neoprene before sliding sleeve over connection.
8. Tape back RED/WHITE or ORANGE *harness* wire (disconnected from ammeter) and insulate ring terminal on end of wire with at least 4 layers of electrical tape.



71613

a - Battery Meter (Voltmeter)
b - BLACK Wire
c - WHITE or PURPLE Wire
d - "I" Terminal Link to Light Bulb Socket
e - RED or RED/PURPLE Wire
f - RED/WHITE or ORANGE Wire (To Ignition Switch)
g - RED/WHITE or ORANGE (From Harness - TAPE-OFF COMPLETELY)
h - Screw and Hex Nut (Inside Item "i")
i - Rubber Sleeve

⚠CAUTION

If an accessory fused panel is to be installed, be sure to connect it at screw, nut and sleeve connection (+) and at BLACK wire terminal (–) on battery meter (voltmeter). Do not connect accessory panel at any other location, as wires in wiring harness may not be of sufficient size to handle current load.

Completing Installation

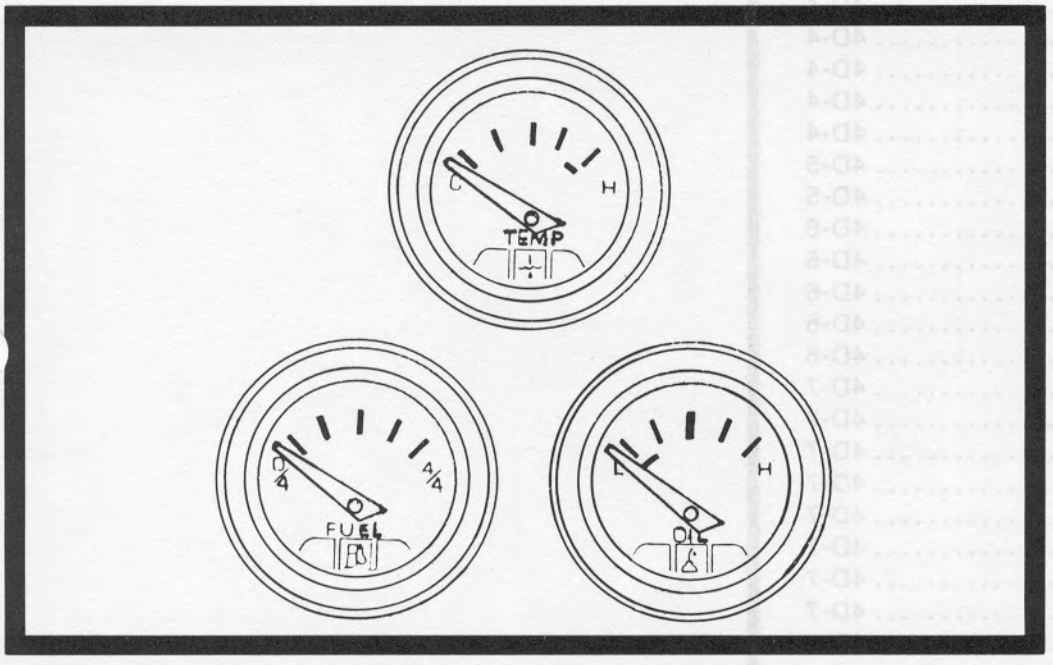
1. Refer to manufacturers instructions, and check that battery is fully charged and charge accordingly if required. Reconnect battery cables. Tighten terminal clamps securely.

⚠CAUTION

Avoid seawater pump impeller, engine or drive unit damage caused by overheating. Before starting engine, a water source must be supplied to seawater pickup pump inlet.

2. Start engine and check for leaks. Check that charging system is functioning properly. Voltmeter should read greater than battery voltage when charging.

ELECTRICAL SYSTEMS



4

D

INSTRUMENTATION

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Gauges	4D-1
Oil, Fuel and Temperature	4D-1
Testing	4D-1
Battery Gauge	4D-2
Testing	4D-2
Cruiselog Meter	4D-2
Testing	4D-2
Vacuum Gauge	4D-3
Testing	4D-3
Speedometer	4D-3
Testing	4D-3
Calibration Chart	4D-3
Tachometer	4D-3
Testing	4D-3
Senders	4D-4
Oil Pressure	4D-4
Testing	4D-4
Water Temperature	4D-4
Fuel Tank Sender	4D-4
Flange Type	4D-4
Testing	4D-4
Capsule Type	4D-5
Testing	4D-5
Switches	4D-6
Ignition Key Switch	4D-6
Testing	4D-6
Emergency Stop Switch	4D-6
Testing	4D-6
Start/Stop Panel	4D-7
Testing	4D-7
Pressure Switch	4D-7
Testing	4D-7
Temperature Switch	4D-7
Testing	4D-7
Audio Warning System	4D-7
Buzzer	4D-7
Testing	4D-7

Gauges

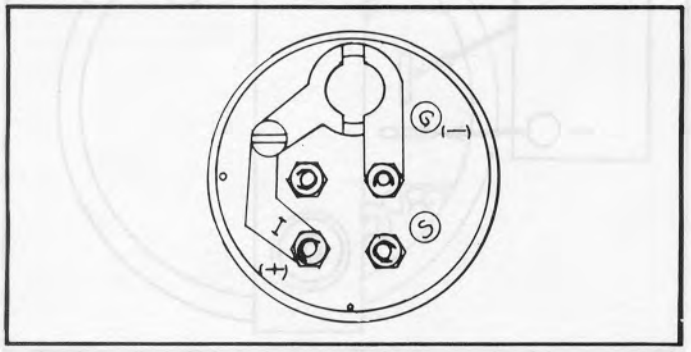
Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

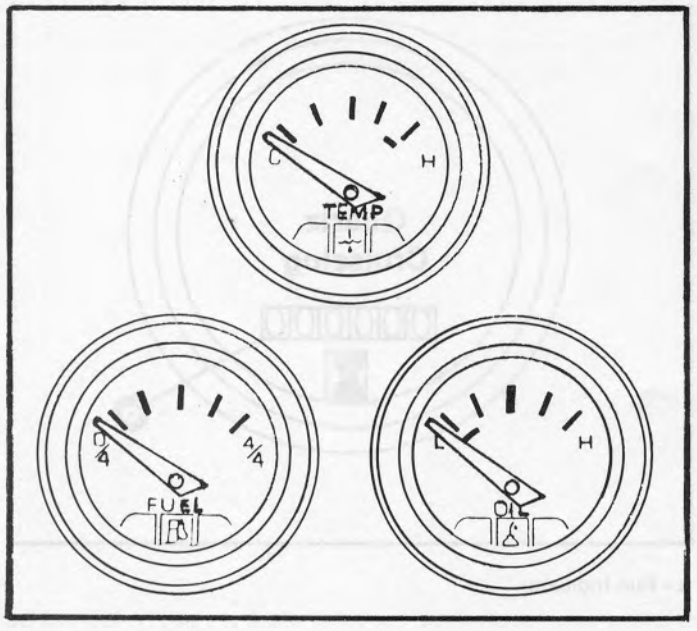
IMPORTANT: DO NOT distort case or bracket by over-tightening.

TESTING

1. Turn ignition switch "Off".
2. Remove wire from terminal "S".

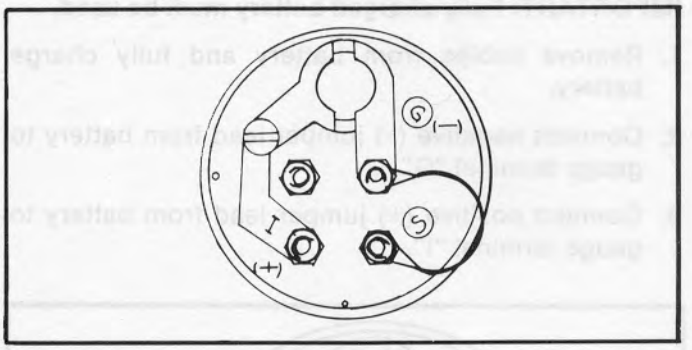


3. Turn ignition switch to "Run". Gauges must be at "A" position.

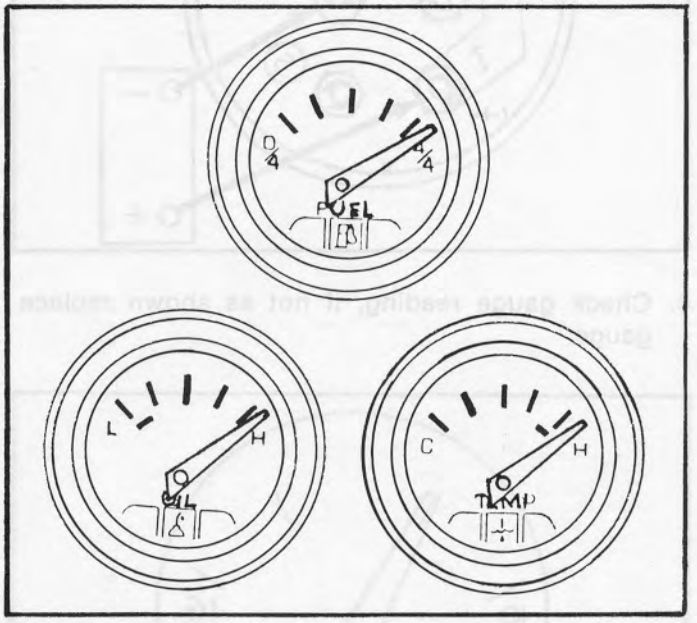


POSITION -A-

4. Turn ignition switch "Off".
5. Connect jumper wire from terminal "G" to terminal "S".



6. Turn ignition switch to "Run".
7. Indicator needle must read at "B". If not, replace gauge.



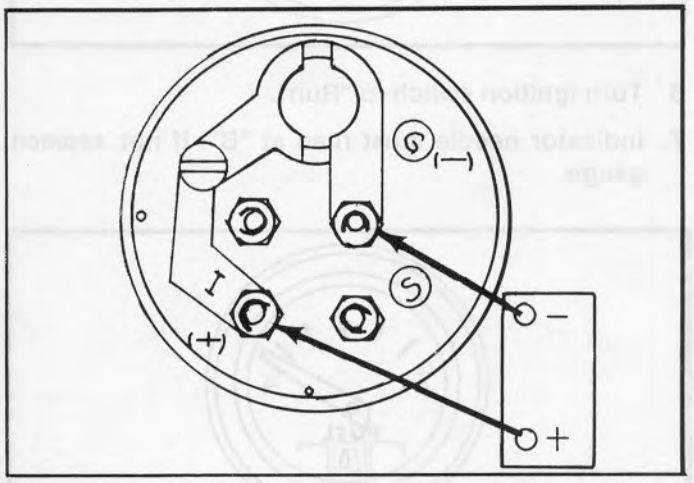
POSITION -B-

Battery Gauge

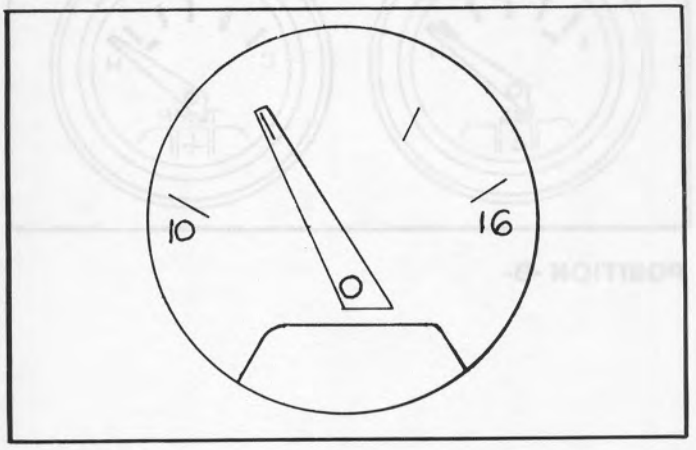
TESTING

IMPORTANT: Fully charged battery must be used.

1. Remove cables from battery and fully charge battery.
2. Connect negative (-) jumper lead from battery to gauge terminal "G".
3. Connect positive (+) jumper lead from battery to gauge terminal "I".



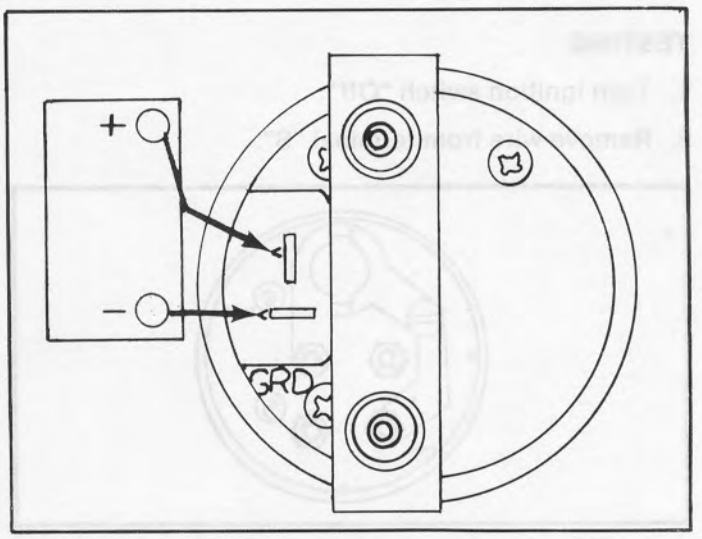
4. Check gauge reading, if not as shown replace gauge.



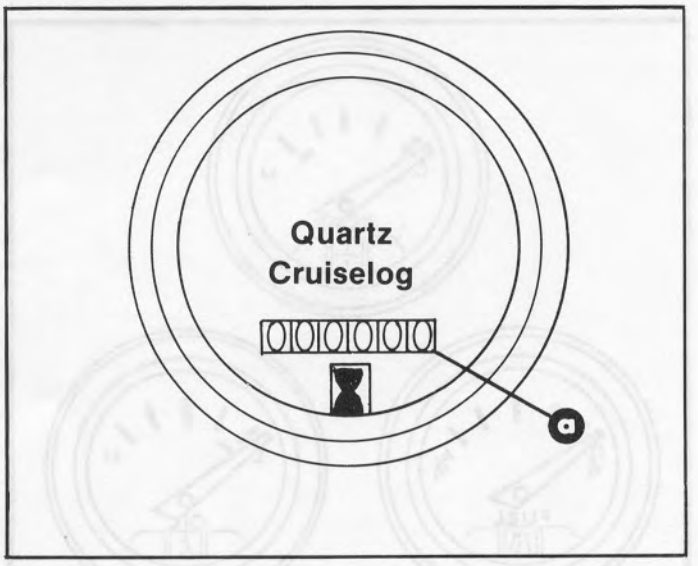
Cruiselog Meter

TESTING

1. Connect jumper wire from negative (-) battery terminal to negative (-) gauge terminal.
2. Connect jumper wire from positive (+) batttery terminal to positive (+) gauge terminal.



3. Observe gauge run indicator, if it is turning gauge is operable, if not replace gauge.



a - Run Indicator

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, air pressure that is used for test must be regulated to specified PSI. DO NOT apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective.

CALIBRATION CHART

Air Pressure Gauge PSI	Speedometer Gauge MPH
5.3	20 ± 1 (32km/hr ± 1.6)
27.8	45 ± 1 (72km/hr ± 1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

TACHOMETER TYPE	ALLOWABLE RANGE
6000 RPM	± 150 RPM
8000 RPM	± 200 RPM

Senders

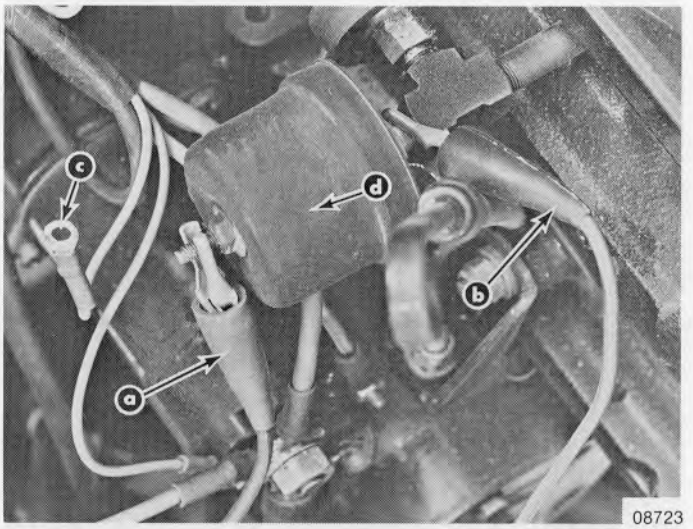
Oil Pressure

TESTING

⚠CAUTION

Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to "Troubleshooting" section.

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



08723

a - Positive Lead
b - Negative Lead
c - Wire Removed
d - Oil Pressure Sender

Oil Pressure (Lbs./Sq. In.)	Ohms Reading	
	Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.25
40	91.7-113.6	45.8-56.8
80	9-49	4.5-24.5

Water Temperature

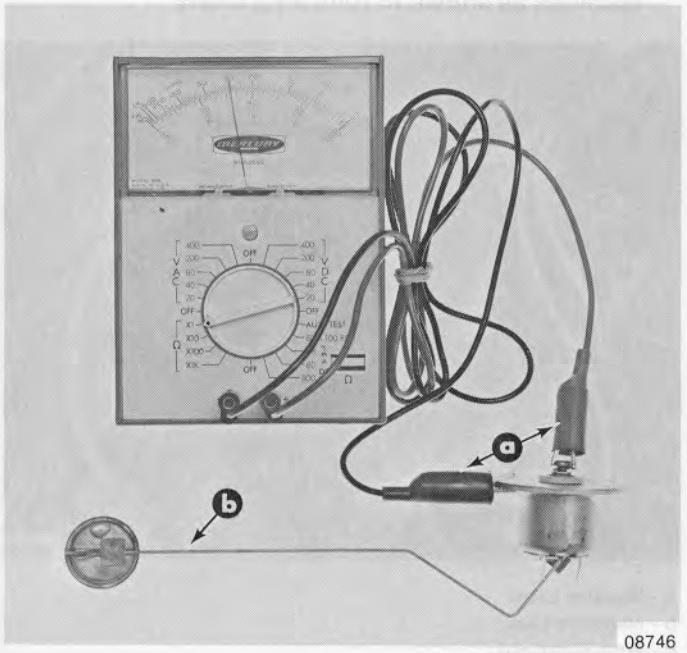
There is no test for sender, install new sender.

Fuel Tank Sender

FLANGE TYPE

Testing

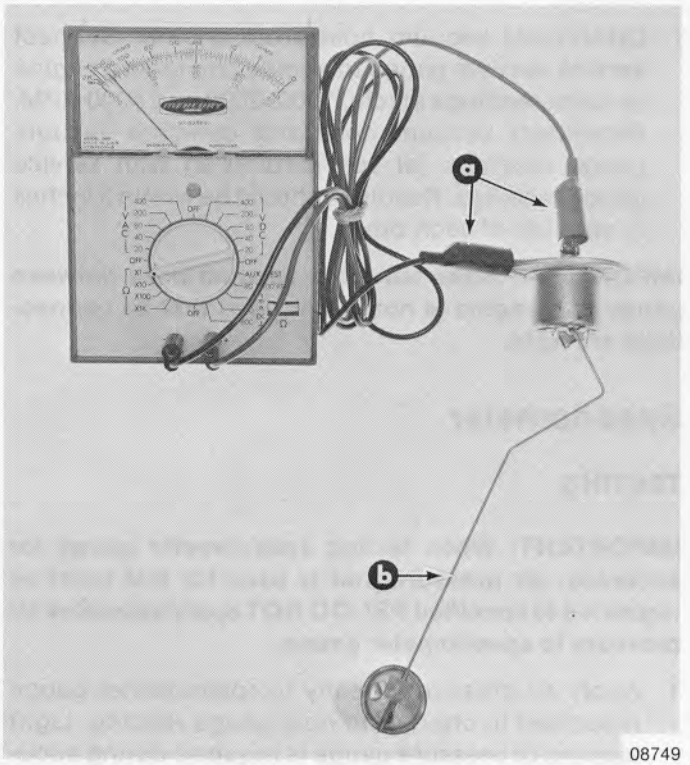
1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohms meter between sending unit terminal and sending unit housing.
4. With float arm in "full" position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



08746

a - Ohmmeter Leads
b - Float Arm Horizontal

5. With float arm in "empty" position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.



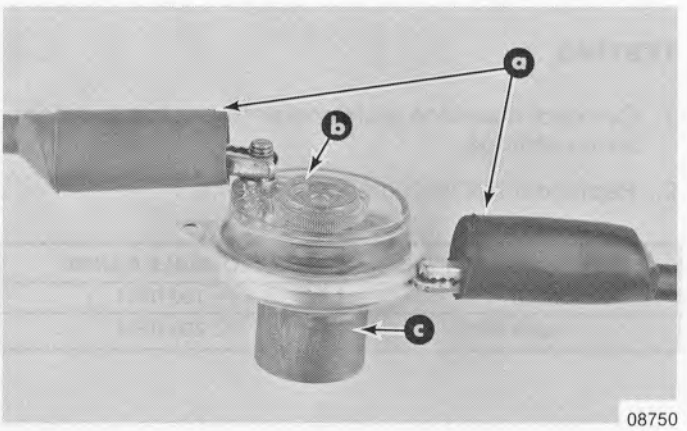
08749

a - Ohmmeter Leads
b - Vertical Float Arm

CAPSULE TYPE

Testing

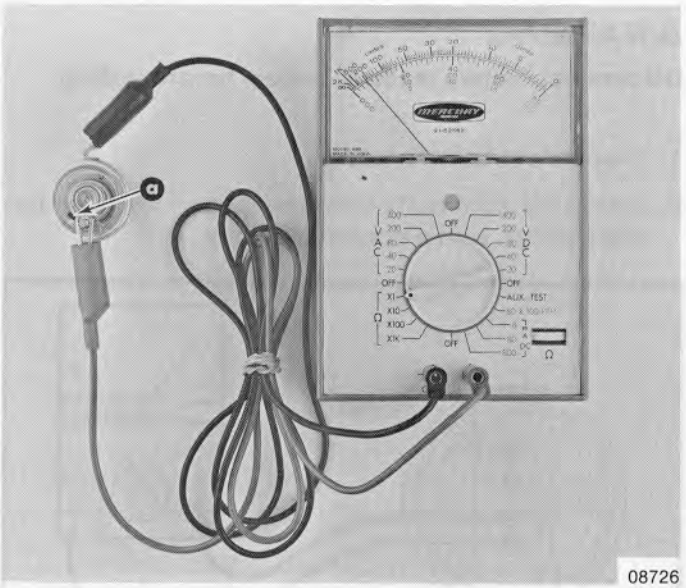
1. Disconnect wire from terminal on fuel tank capsule.
2. Remove 2 screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



08750

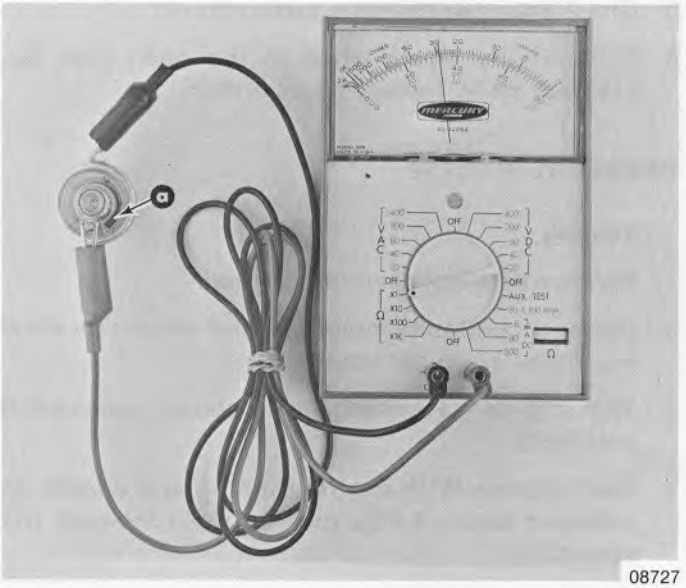
a - Ohmmeter Leads
b - Capsule Assembly
c - Magnet

5. Turn magnet counterclockwise until fuel capsule indicator reads empty. Ohmmeter should read 240 ohms (±5 ohms).



a - Capsule Reading Empty

6. Turn magnet clockwise until fuel capsule indicator reads "Full". Ohmmeter should read 30 ohms (±5 ohms). Fuel capsule is defective if not within specifications.



a - Capsule Reading Full

Switches

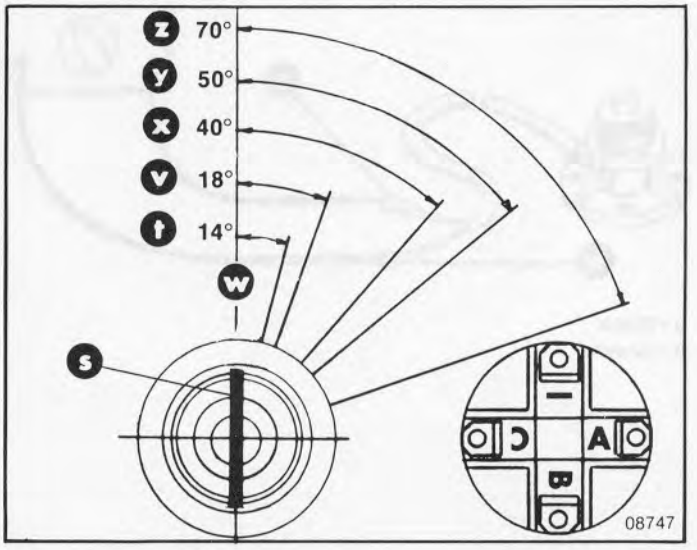
Ignition Key Switch

TESTING

⚠CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
2. With key switch in "Off", there should be no continuity between switch terminals.
3. With key switch in "Run", continuity will exist between switch terminal "B" to "A" and "B" to "I". There should be no continuity between terminal "C" and any other terminals.
4. With key switch in "Start", continuity will exist between terminal "B" to "A", "B" to "I" and "B" to "C".
5. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward "Start".
6. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-thru-5, preceding. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.



KEY VIEW BACK VIEW

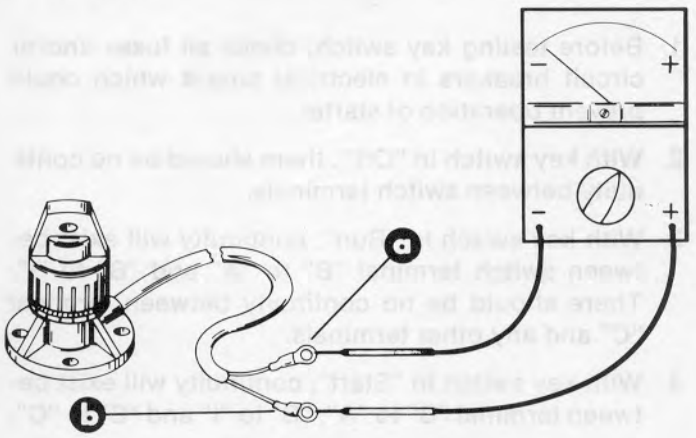
S - Key
W - Off
T - Continuity, B-A Terminals
V - Continuity, B-I Terminals
X - Run
Y - Continuity, B-C Terminals
Z - Start

Emergency Stop Switch

TESTING

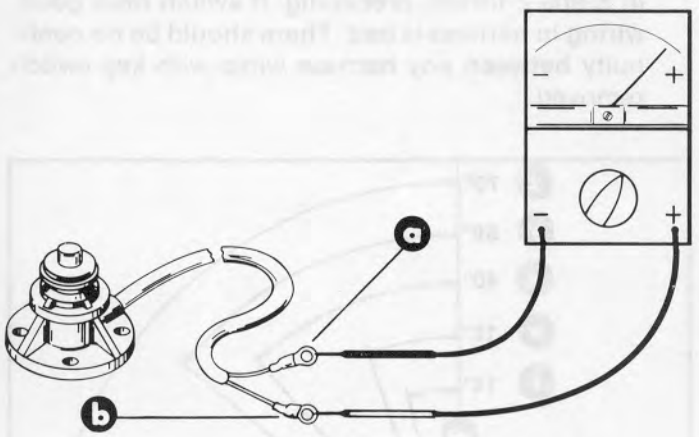
IMPORTANT: White lead must be taped back.

1. Remove leads from connections.
2. Using a test meter, check with the switch cap on, for continuity between black and green, no continuity can exist.



a - Black
b - Green

3. With cap off continuity must exist between black and green.



a - Black
b - Green

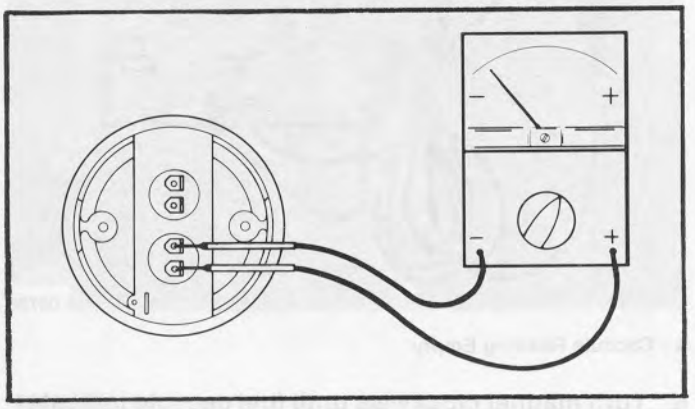
Start/Stop Panel

TESTING

⚠WARNING

Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.

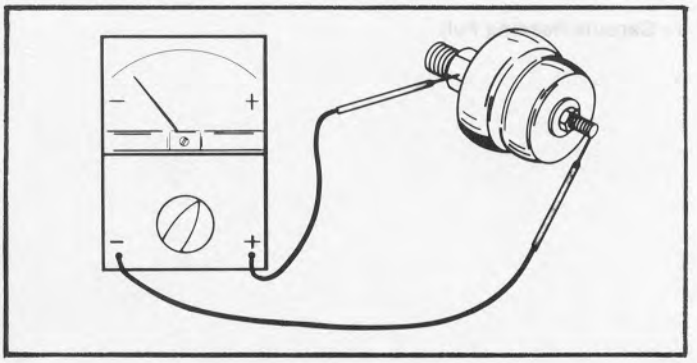


3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the open (not depressed) state, replace panel button.

PRESSURE SWITCH

Testing

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and metal of sender case.
3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI, meter should indicate NO continuity.



TEMPERATURE SWITCH

Testing

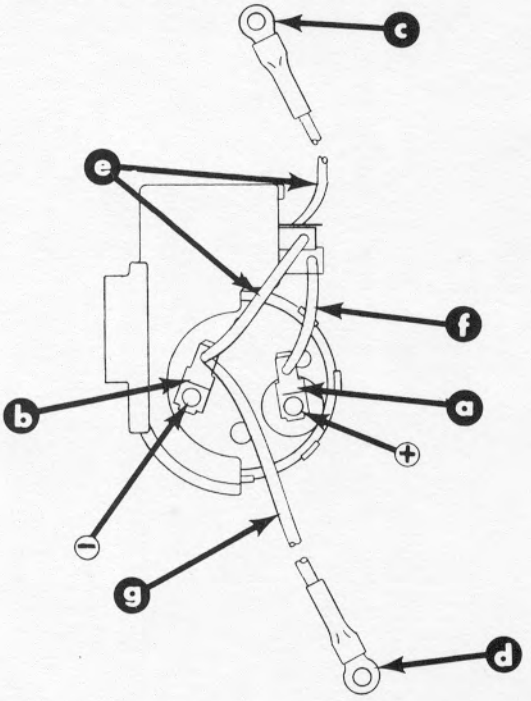
1. Remove wire from terminal.
2. Remove sender.
3. Connect continuity meter between sender terminal and metal case.
4. With sender cold no continuity should exist.
5. Heat sender to 190°-200°F (31°-34°C).
6. Continuity should exist.

Audio Warning System

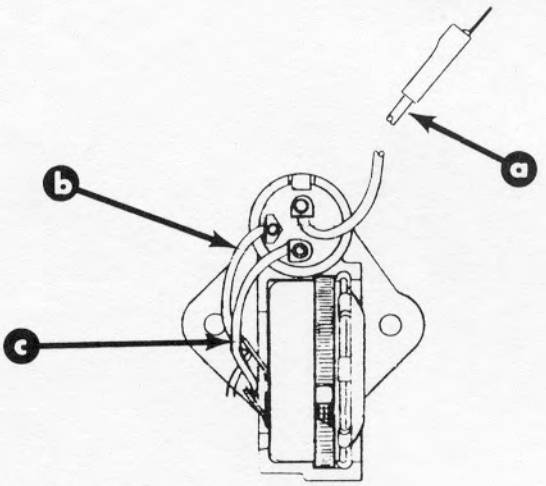
BUZZER

Testing

1. Turn key to "Run" position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
4. If horn worked in step 3:
   a. Connect jumper wires as shown.
   b. Repeat step 2.
   c. If horn sounds, problem is in tan/blue wire back to engine or switches on engine.



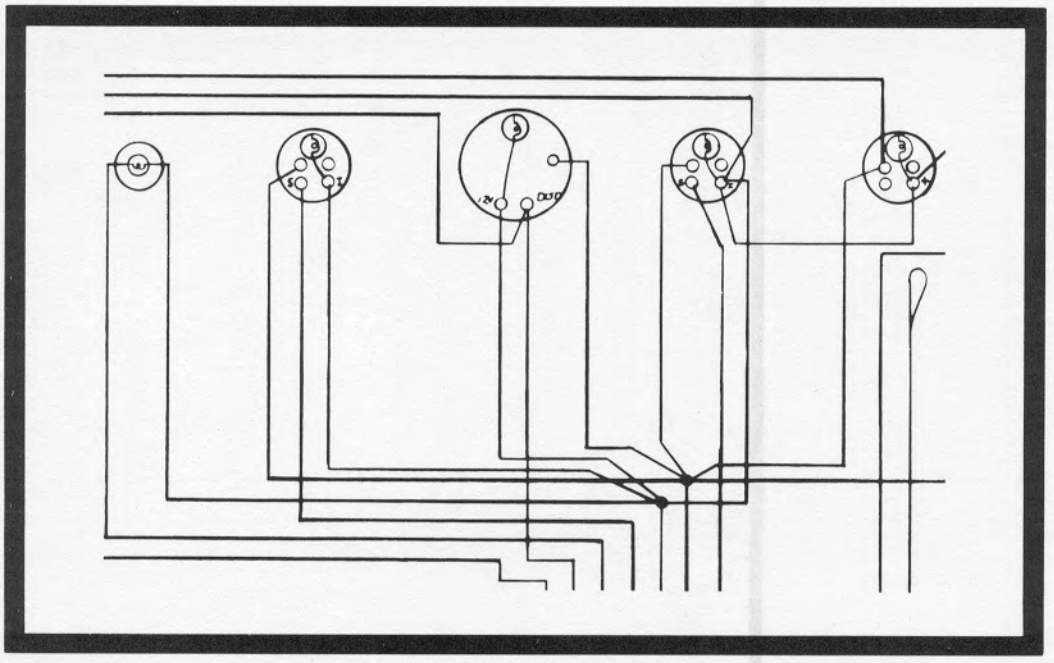
a - Jumper Wire to 12-V (+) — STEP 3
b - Jumper Wire to Ground (-) — STEP 3
c - Jumper Wire to 12-V (+) — STEP 4
d - Jumper Wire to Ground (-) — STEP 4
e - Purple Wire
f - Red Wire
g - Tan/Blue Wire



a - Purple Wire
b - Purple Jumper Wire
c - Red Jumper Wire

a - Purple Wire
b - Purple Jumper Wire
c - Red Jumper Wire

ELECTRICAL SYSTEMS



4

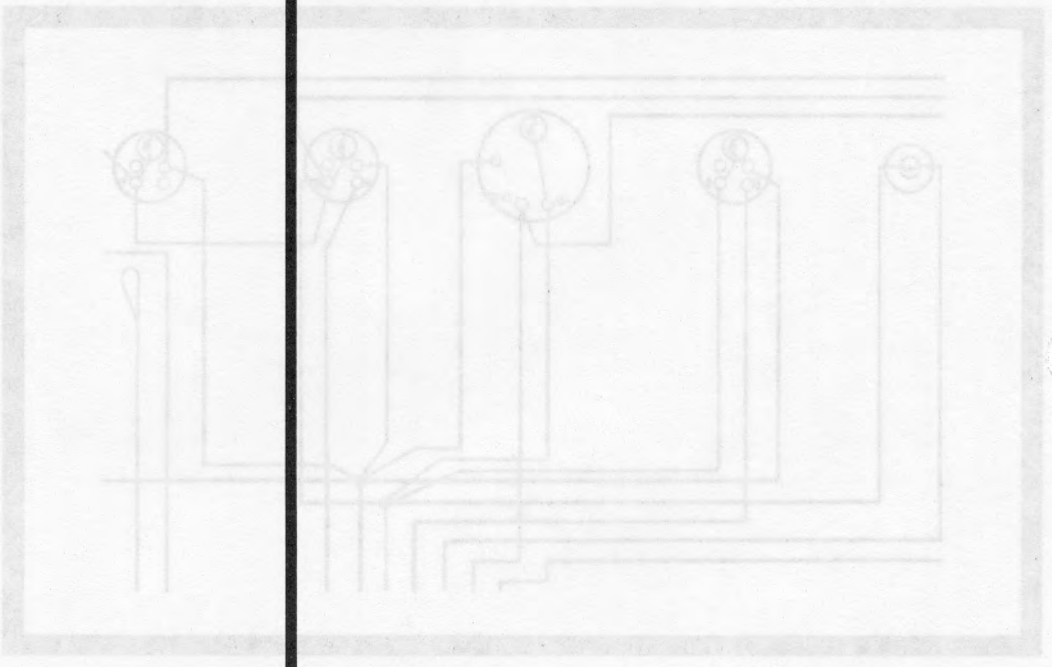
E

WIRING DIAGRAMS

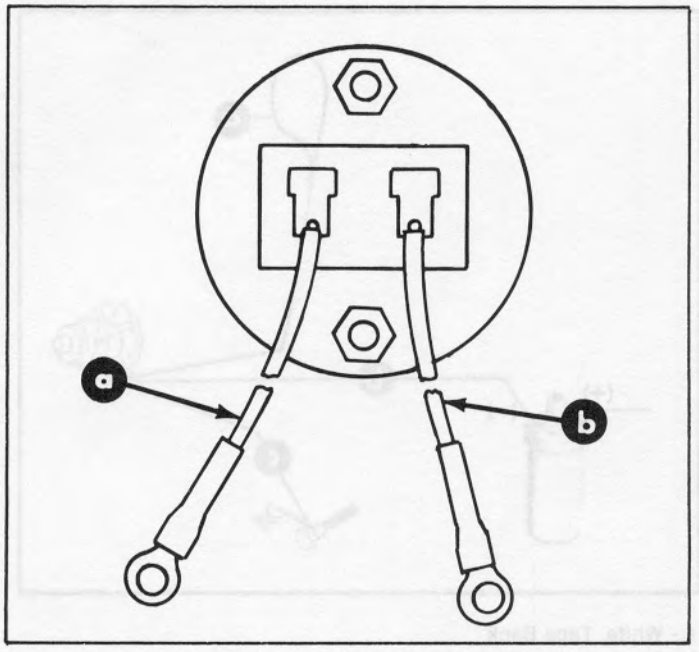
mercruiser
STERN DRIVES & INBOARDS

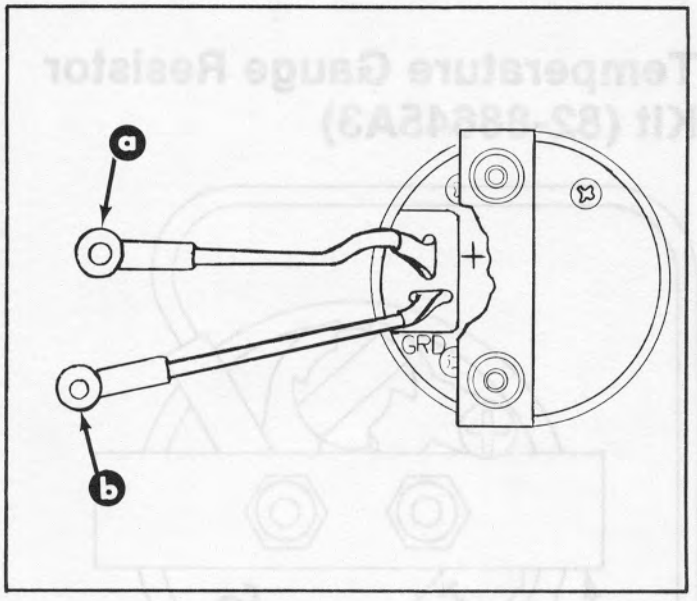
INDEX

	Page
Cruiselog	4E-1
Fuel Gauge and Sender	4E-1
Quartz Clock	4E-2
Audio Warning System	4E-2
Emergency Stop Switch	4E-2
Temperature Gauge Resistor Kit	4E-2
Dual Station (With Neutral Safety Switch in Both Remote Controls)	4E-3
Dual Station (With Neutral Safety Switch in One Remote Control)	4E-4
Dual Station (With Safety Switch in Engine Wiring Harness)	4E-5
Instrumentation	4E-6
Engine Wiring	4E-7
Power Trim Wiring Diagram	4E-8



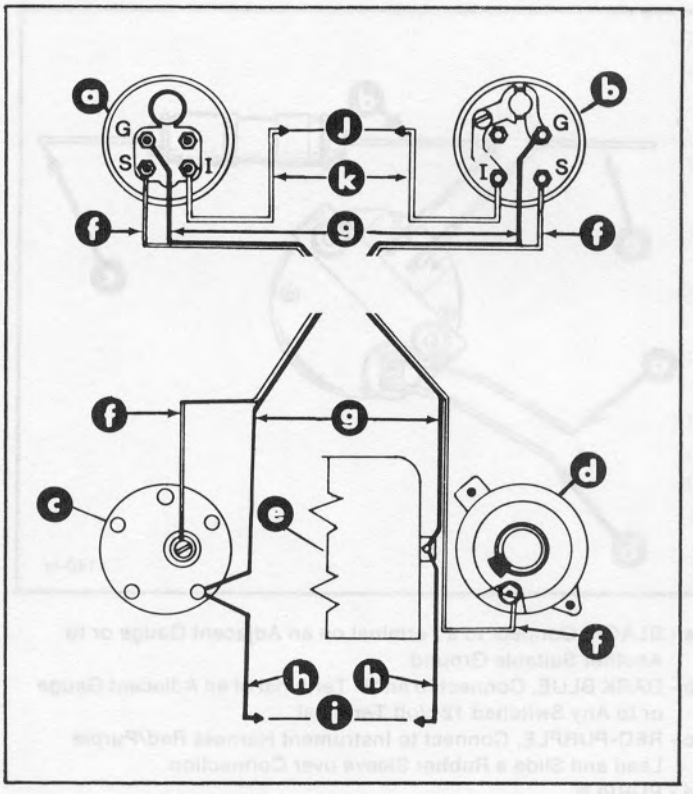
Cruiselog





a - Purple, Connect to Ignition Switch Activated 12-Volt Positive (+) Source
b - Black, Connect to Negative (-) Ground

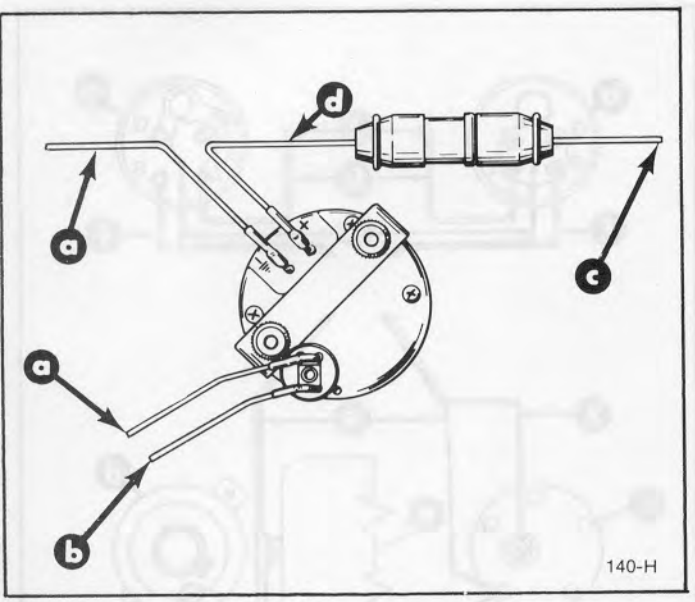
Fuel Gauge and Sender



a - Fuel Gauge (Blue or Brass Case)
b - Fuel Gauge (Black Case)
c - Tank Sender
d - Sender Capsule
e - Fuel Tank
f - Pink
g - Black
h - Black Lead
i - Connect to Negative Battery Terminal or Suitable Ground
j - Connect to Ignition Terminal or Accessory Terminal of Ignition Switch
k - White

NOTE: Either gauge uses either sender.

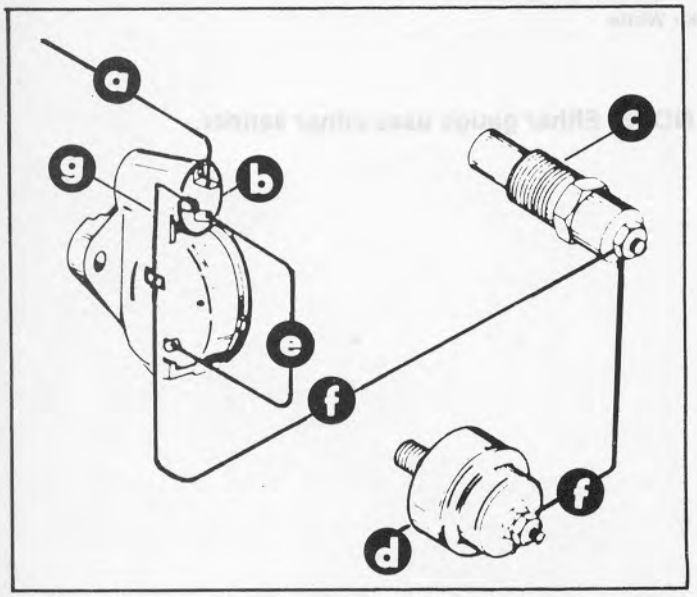
Quartz Clock



a - BLACK, Connect to a Terminal on an Adjacent Gauge or to Another Suitable Ground
b - DARK BLUE, Connect to an "I" Terminal of an Adjacent Gauge or to Any Switched 12-Volt Terminal
c - RED-PURPLE, Connect to Instrument Harness Red/Purple Lead and Slide a Rubber Sleeve over Connection
d - PURPLE

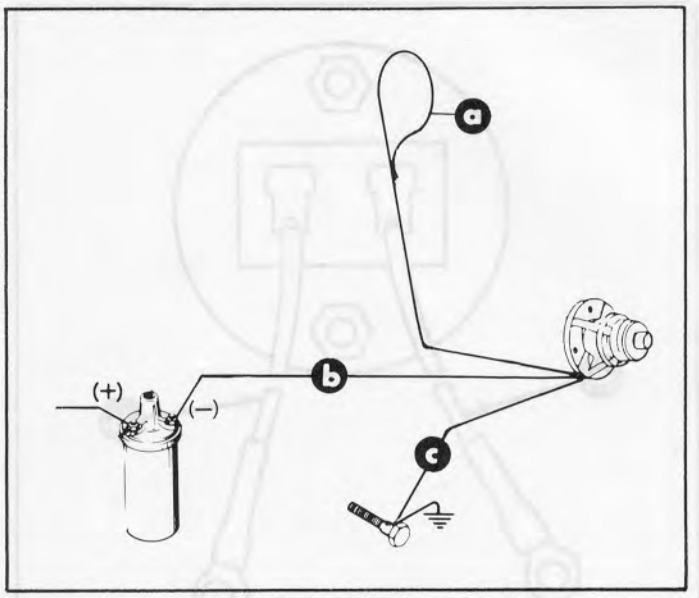
⚠WARNING
Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.

Audio Warning System



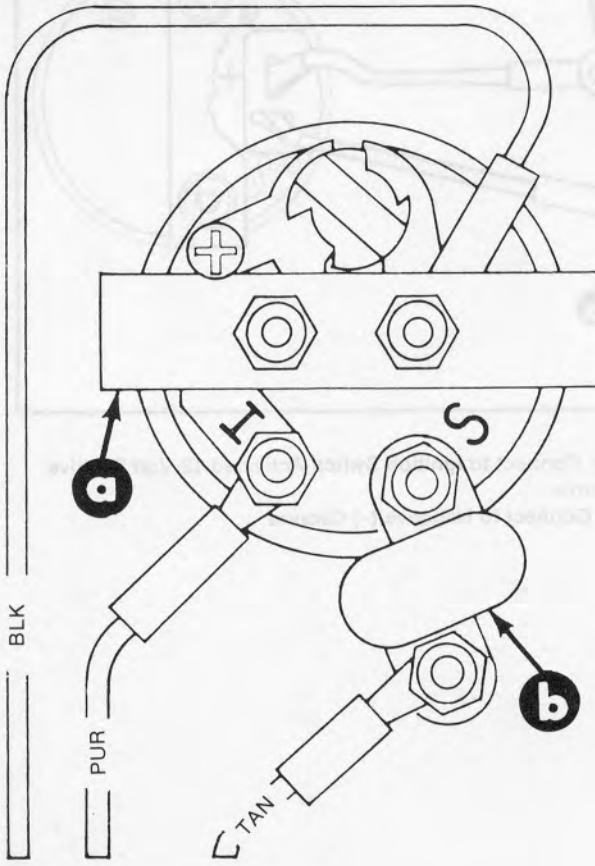
a - To 12V Source - Purple
b - Audio Warning Buzzer
c - Water Temperature Heat Switch
d - Oil Pressure Switch
e - Red
f - Tan-Blue
g - Purple

Emergency Stop Switch



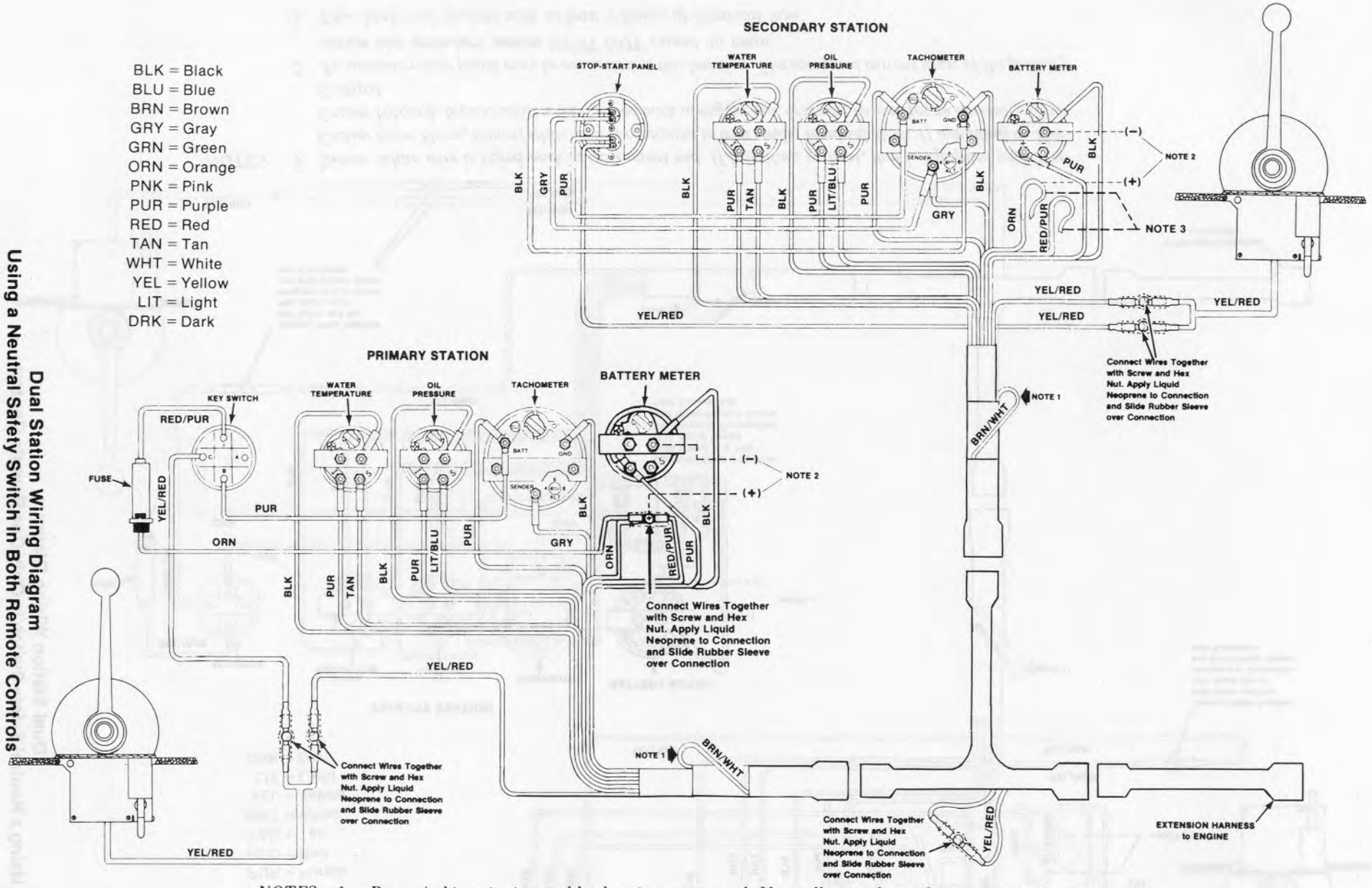
a - White, Tape Back
b - Black, to Negative on Ignition Coil
c - Green, to Ground

Temperature Gauge Resistor Kit (82-88645A3)



a - Mounting Bracket
b - Temperature Gauge Resistor

Dual Station Wiring Diagram
Using a Neutral Safety Switch in Both Remote Controls

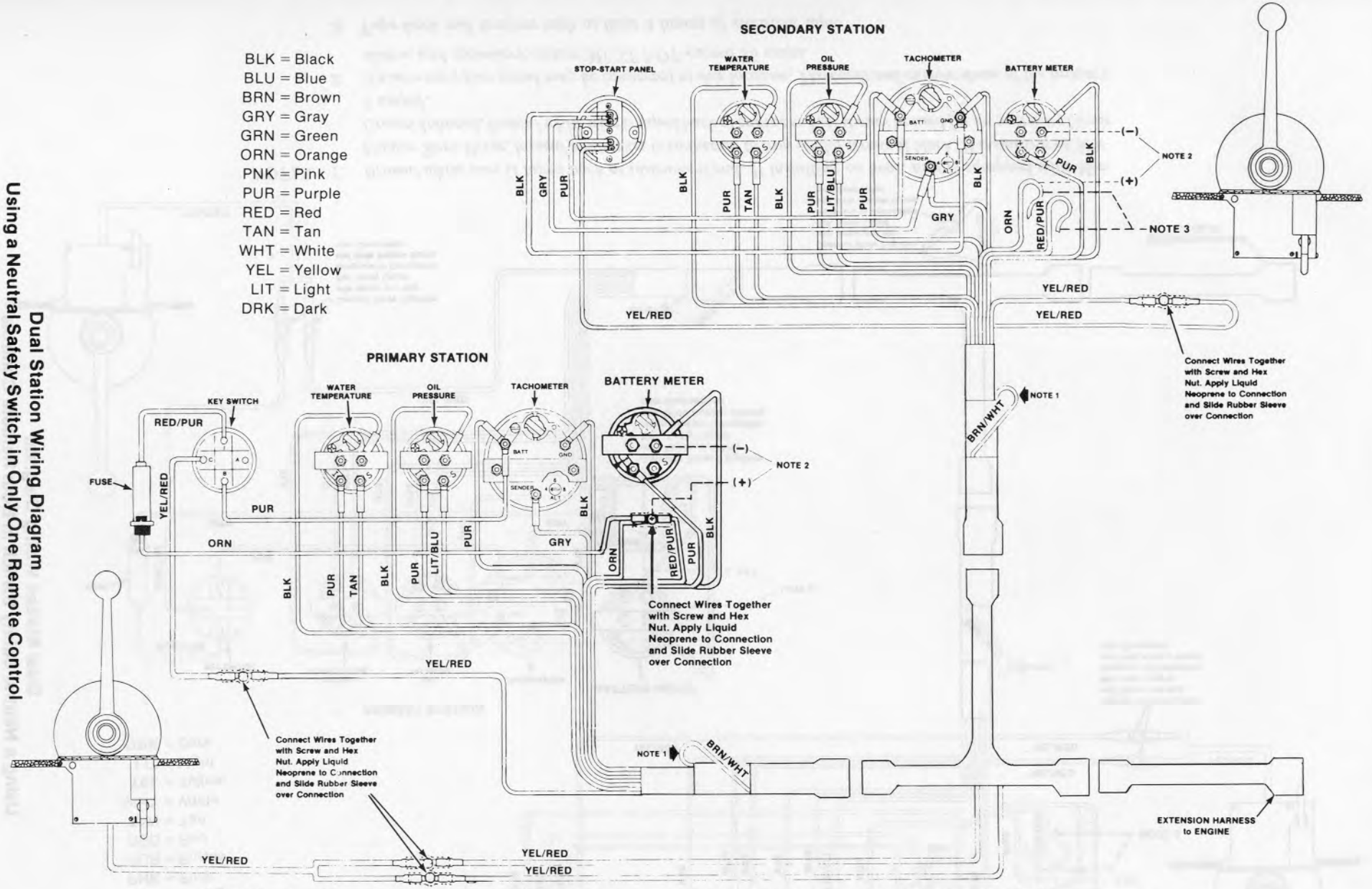


NOTES:

1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*
3. *Tape back and insulate with at least 4 layers of electrical tape.*

Dual Station Wiring Diagram
Using a Neutral Safety Switch in Only One Remote Control

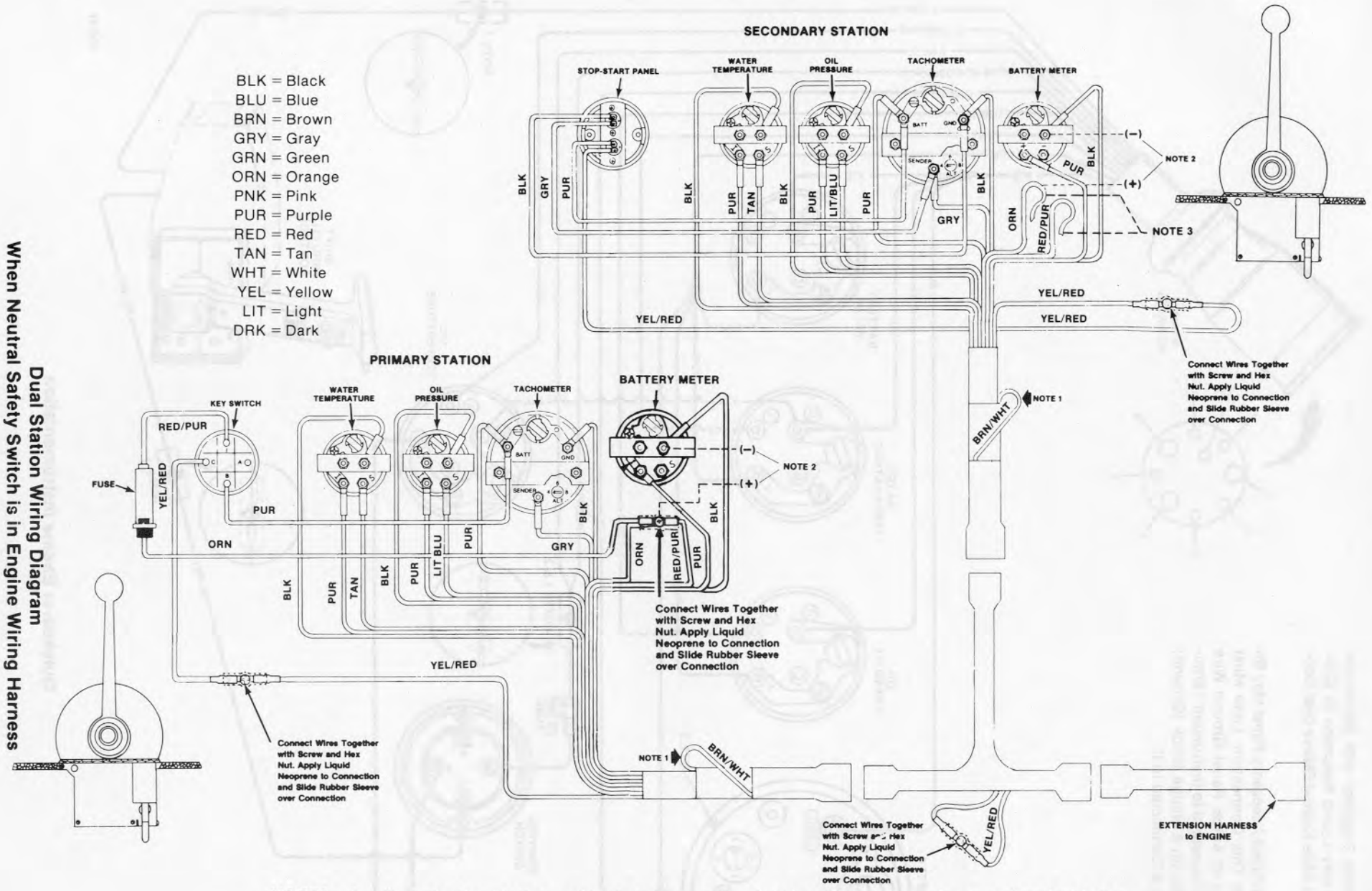
BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark



NOTES:

1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*
3. *Tape back and insulate with at least 4 layers of electrical tape.*

Dual Station Wiring Diagram
When Neutral Safety Switch is in Engine Wiring Harness

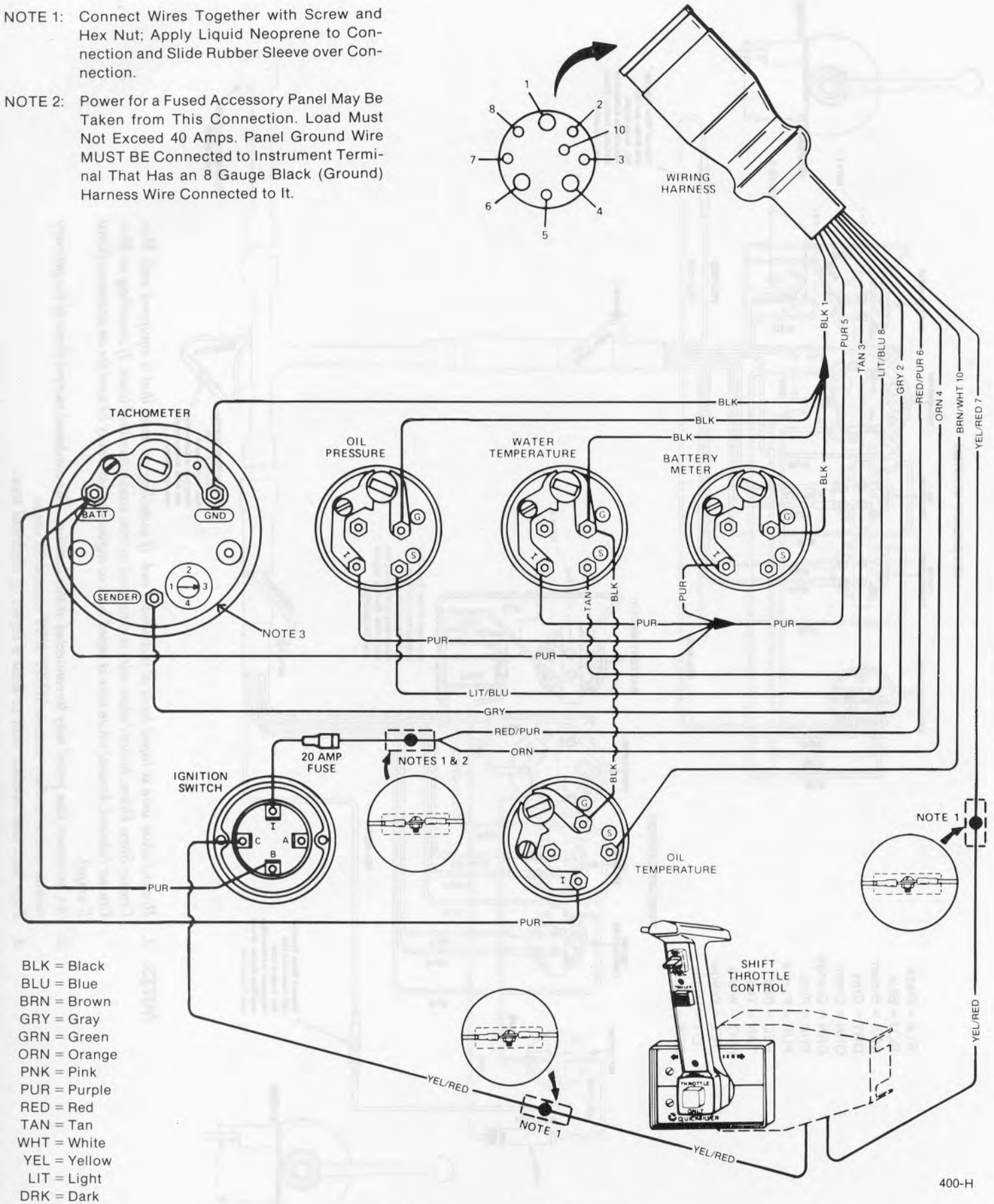


NOTES:

1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*
3. *Tape back and insulate with at least 4 layers of electrical tape.*

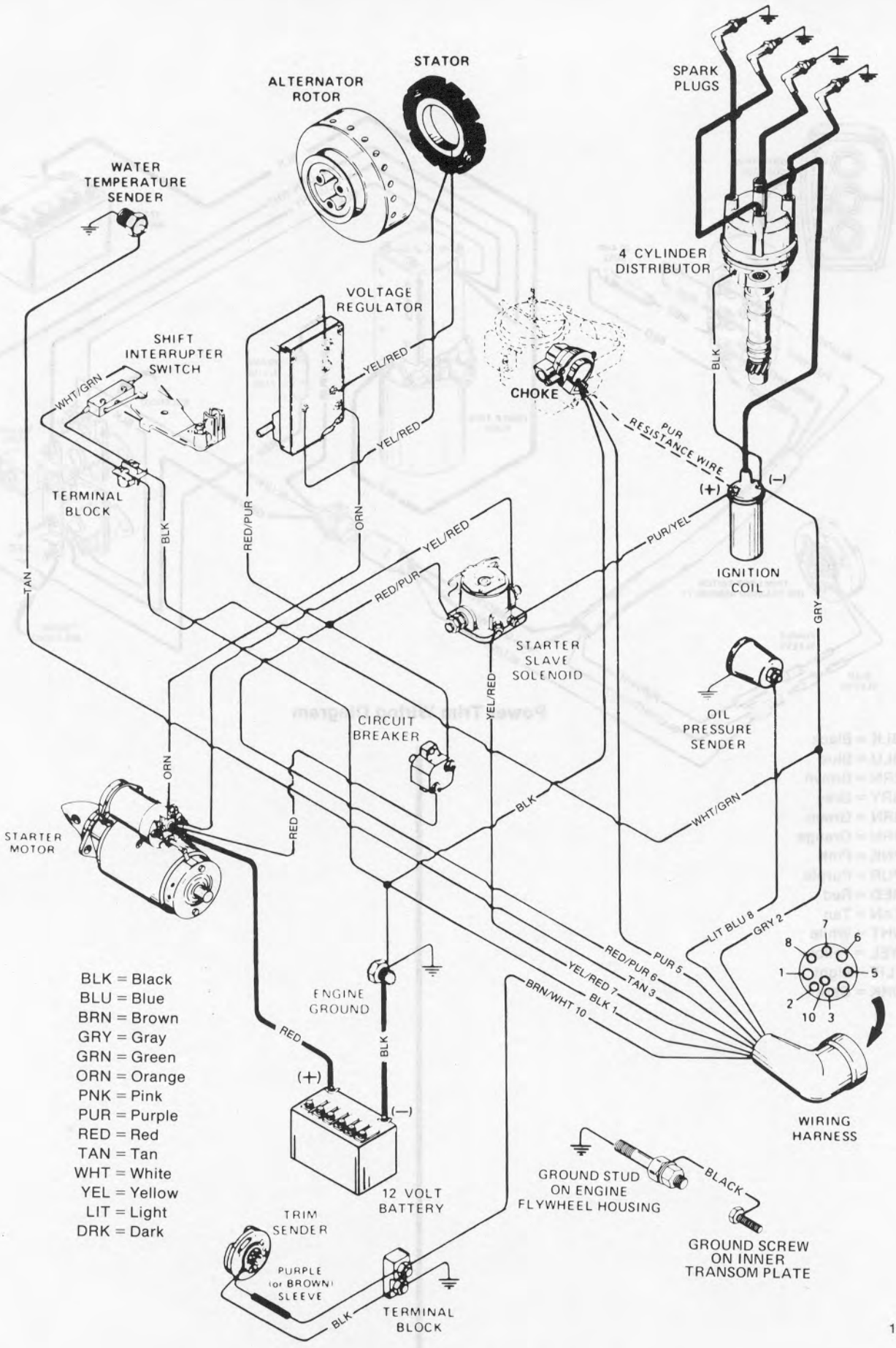
NOTE 1: Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Sleeve over Connection.

NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.

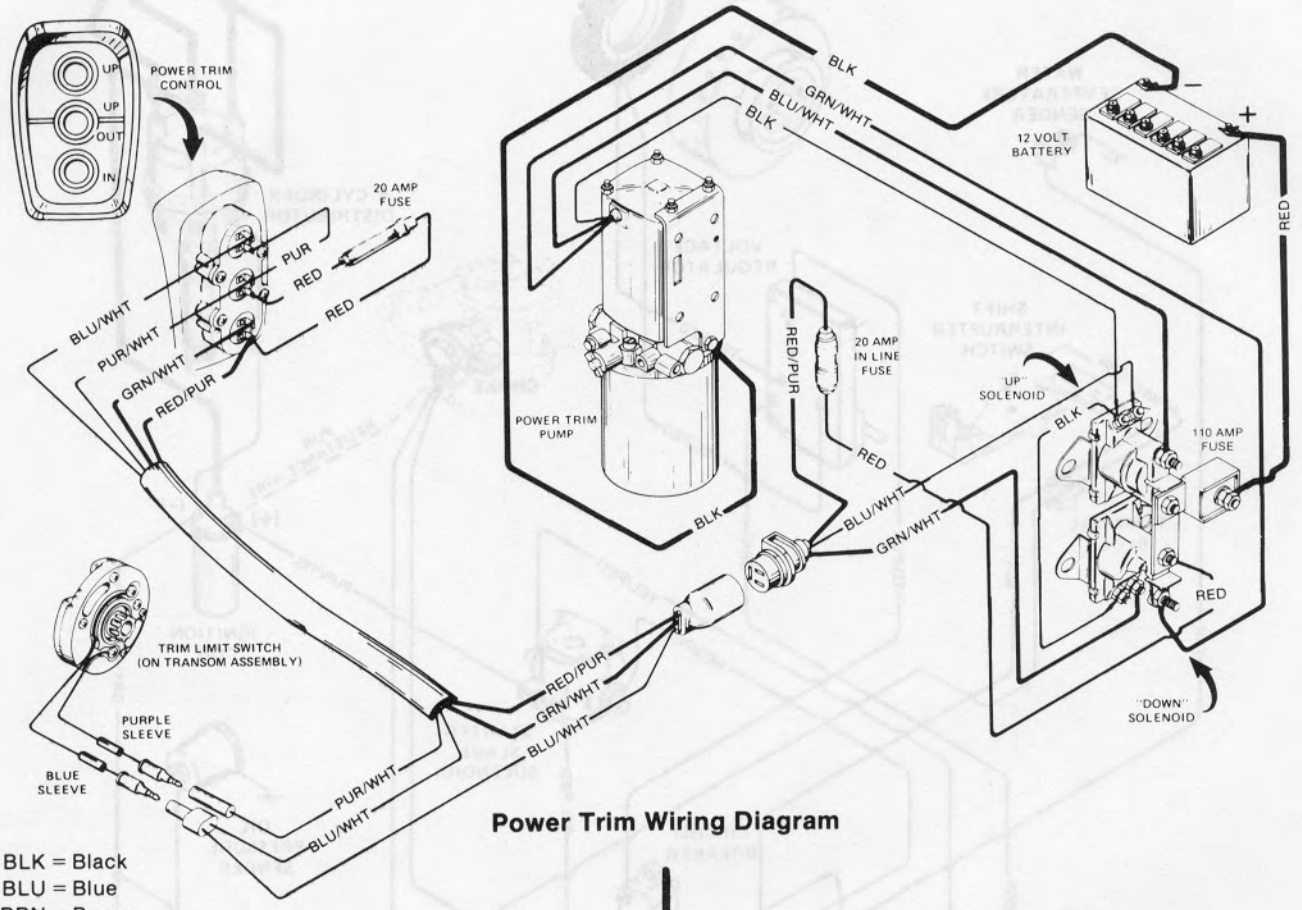


BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

Quicksilver Engine Instrumentation



Engine Electrical System Wiring Diagram

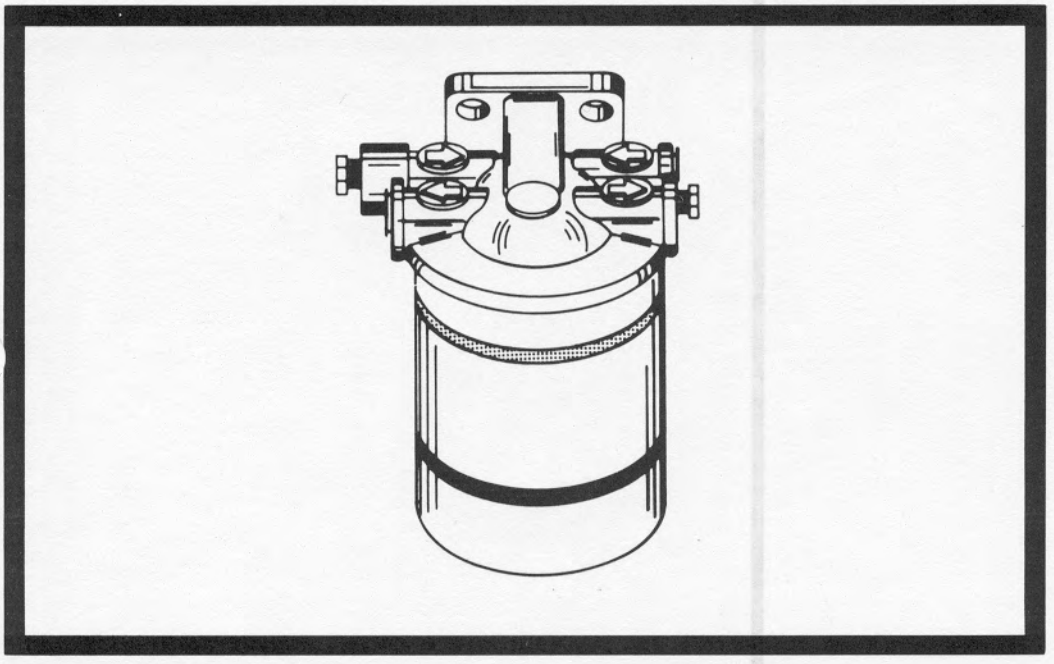


334-H

Power Trim Wiring Diagram

BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

FUEL SYSTEMS



FUEL DELIVERY SYSTEM

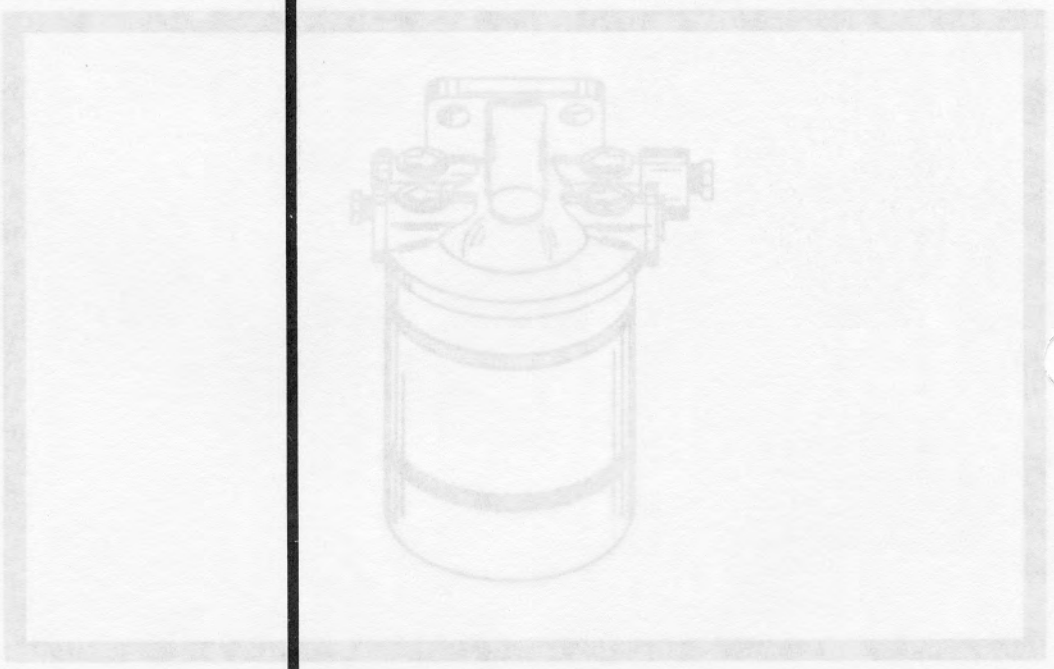
5

A

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Requirements	5A-1
Water Separating Fuel Filter	5A-1



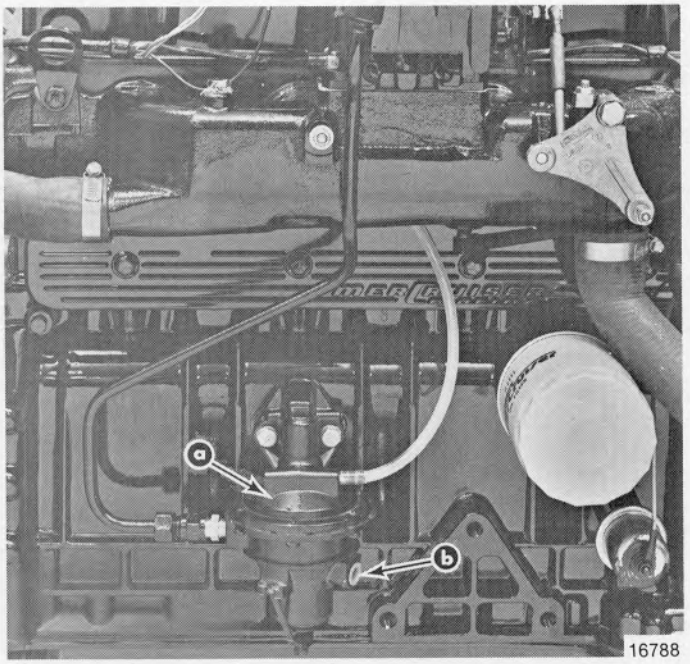
5A

Fuel Delivery System

REQUIREMENTS

IMPORTANT: Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

IMPORTANT: The "Fire Protection Standard" for Motor Craft (Pleasure and Commercial) is available from the National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts, 02210. Designated NFPA 302, this standard indicates current good practice toward making gasoline, diesel and outboard powered boats as free as possible from the hazards of fire and explosion.



a - Fuel Pump
b - Remove Shipping Plug and Connect Flexible Fuel Line Here

WATER SEPARATING FUEL FILTER

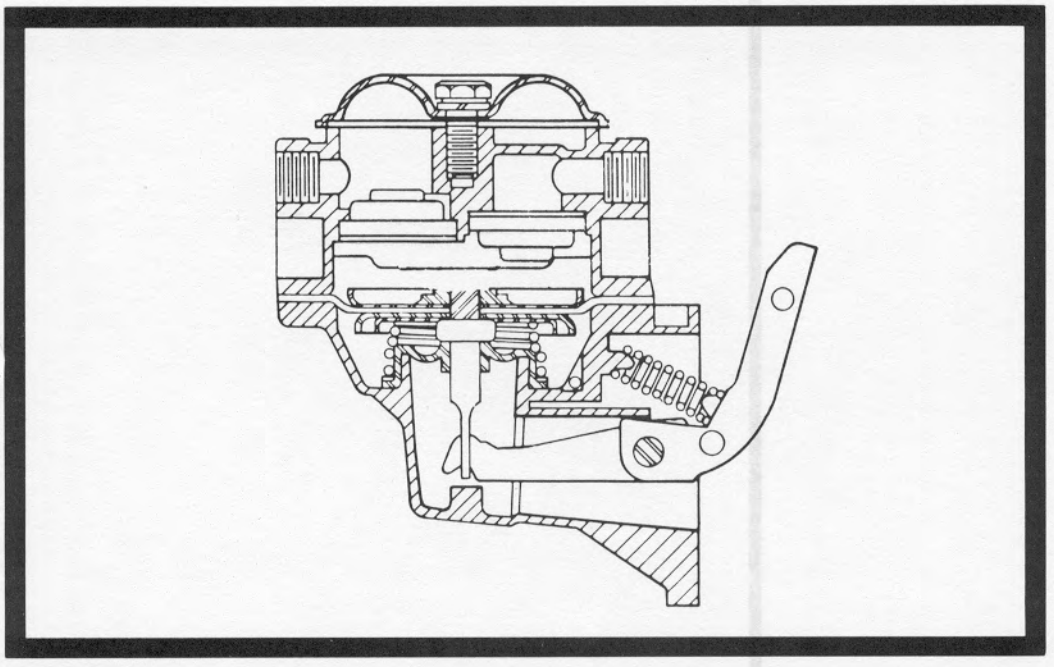
Canister type fuel filter and water separating unit offered as an accessories kit.

The canister is a replaceable non-cleanable type.

Kit-Filter and Mounting Bracket 805269--1

Replacement Element 805269A4

FUEL SYSTEMS



FUEL PUMP

5

B

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Carter Fuel Pump	5B-1
Specifications	5B-1
Torque	5B-1
Sealants	5B-1
Special Tools	5B-1
Identification	5B-2
Replacement Parts	5B-2
System Components	5B-3
System Description	5B-3
Pressure Test	5B-3
Sight Tube Inspection	5B-4
Repair	5B-4
Filter Replacement	5B-4
Removal	5B-5
Cleaning and Inspection	5B-5
Installation	5B-5

Carter Fuel Pump

Specifications

Fuel Line Pressure	3-6 psi (21-41 kPa)

Torque

FASTENER LOCATION	LBS. FT. (N.m)	LBS. IN. (N.m)
Inlet Fitting to Pump	10-18 (13.5-27)	
Outlet Fitting to Pump	10-18 (13.5-27)	
Pump to Block	20 (27)	

Sealants

Loctite #69 Hydraulic Sealant
Loctite Pipe Sealant with Teflon

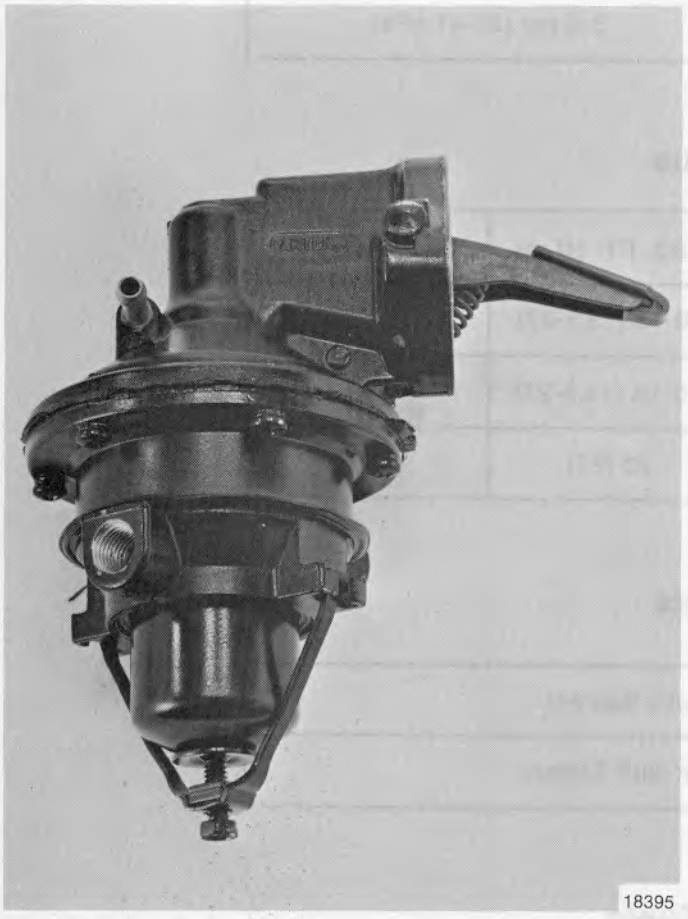
Special Tools

FUEL PRESSURE GAUGE	J29658
KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	

Identification

CARTER FUEL PUMP

Replaceable fuel filter element, non-replaceable diaphragm.



REPLACEMENT PARTS

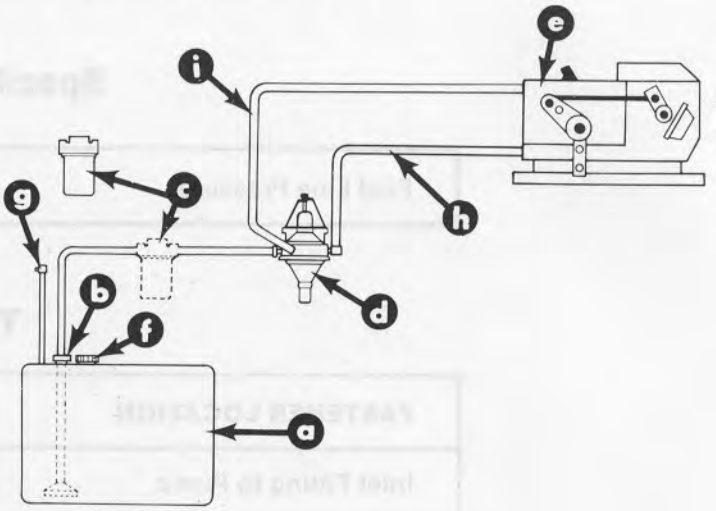
⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

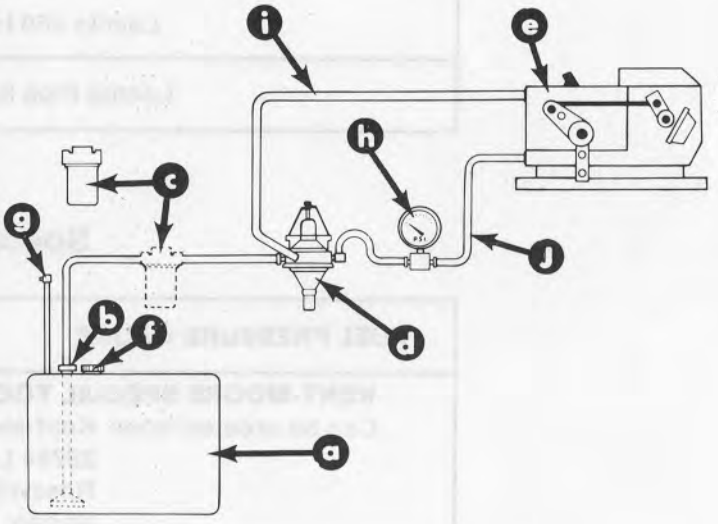
Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation, and therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt and brackish water that will rust or corrode standard automotive parts within a short period of time.

SYSTEM COMPONENTS



a - Fuel Tank
b - Anti-Siphon Valve
c - Water Separating Fuel Filter (Optional)
d - Fuel Pump
e - Carburetor
f - Fuel Filler
g - Vent Hose
h - Fuel Line
i - Sight Tube



With Pressure Test Kit Installed

a - Fuel Tank
b - Anti-Siphon Valve
c - Water Separating Fuel Filter (Optional)
d - Fuel Pump
e - Carburetor
f - Fuel Filler
g - Vent Hose
h - Pressure Test Gauge
i - Sight Tube
j - Fuel Line

SYSTEM DESCRIPTION

The fuel system is a three part system consisting of the fuel tank, fuel pump and the carburetor.

The fuel is stored in the tank and with the engine cranking is drawn from the tank by a mechanically operated pump. The pump is driven by the rotation of the engine camshaft.

The fuel is pushed through the pump and supplied to the carburetor where it is precisely metered and fed into the engine.

An in-line anti-siphon valve, if so equipped, should be mounted as near the tank as possible to prevent fuel from draining from the tank should a break in the line occur. An optional in-line fuel filter can also be installed between the anti-siphon valve and fuel pump.

PRESSURE TEST

⚠CAUTION

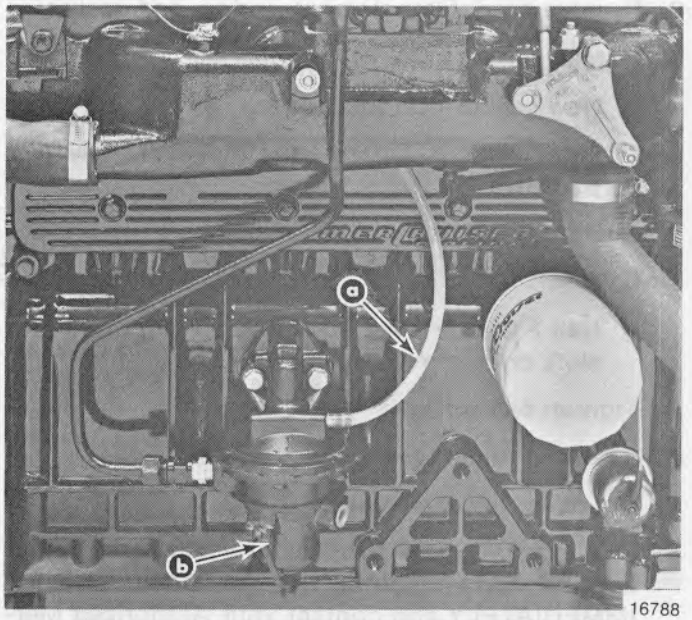
Before servicing the fuel system, always disconnect BOTH battery terminals. This will prevent accidental shorting which may ignite fuel that is spilled when fuel lines are disconnected.

1. Disconnect fuel line from output side of pump.
2. Attach pressure gauge lines between pump and existing fuel line.
3. Start engine and run at idle, observe gauge reading.
4. Pressure must be constant at 5-1/4 to 6-1/2 psi when at idle to 1000 RPM.
5. If variation, or too high or too low pressure is noted, replace pump.
6. Remove gauge and reconnect fuel line.
7. Reinspect for leaks.

SIGHT TUBE INSPECTION

The fuel pump is equipped with a sight tube to give you visible evidence of a ruptured fuel pump diaphragm.

IF FUEL IS VISIBLE IN TUBE, REPLACE FUEL PUMP IMMEDIATELY.



16788

a - Sight Tube
b - Fuel Pump

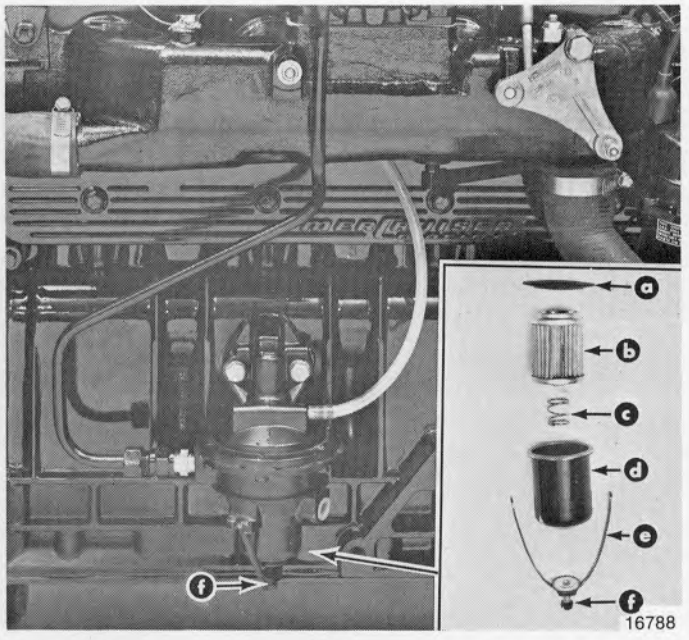
⚠WARNING

Be careful when changing fuel pump fuel filter; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when changing fuel filter. Wipe up any spilled fuel immediately.

Repair

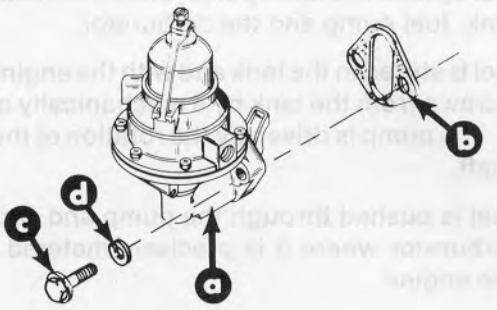
FILTER REPLACEMENT

1. Loosen screw above filter bowl and release bail from fuel pump housing.
2. Remove bowl, filter element, spring, and gasket.
3. Install:
   a. New gasket - On fuel pump.
   b. Filter element - Open end of filter element MUST BE down.
   c. Spring - On top of filter element.
   d. Bowl.
   e. Bail - Center over bowl and secure ends into slots on pump housing.
4. Tighten bail screw.
5. Start and run engine.
6. Check for gasoline leaks.
7. If leaks exist, STOP ENGINE and recheck connections. If leaks continue to exist, STOP ENGINE IMMEDIATELY and contact your Authorized MerCruiser Dealer.



a - Gasket
b - Filter Element
c - Spring
d - Bowl
e - Bail
f - Bail Screw

REMOVAL



a - Fuel Pump
b - Fuel Pump Gasket
c - Bolt
d - Lock Washer

1. Disconnect fuel lines at pump and cap lines.
2. Remove mounting bolts, pump and gasket.

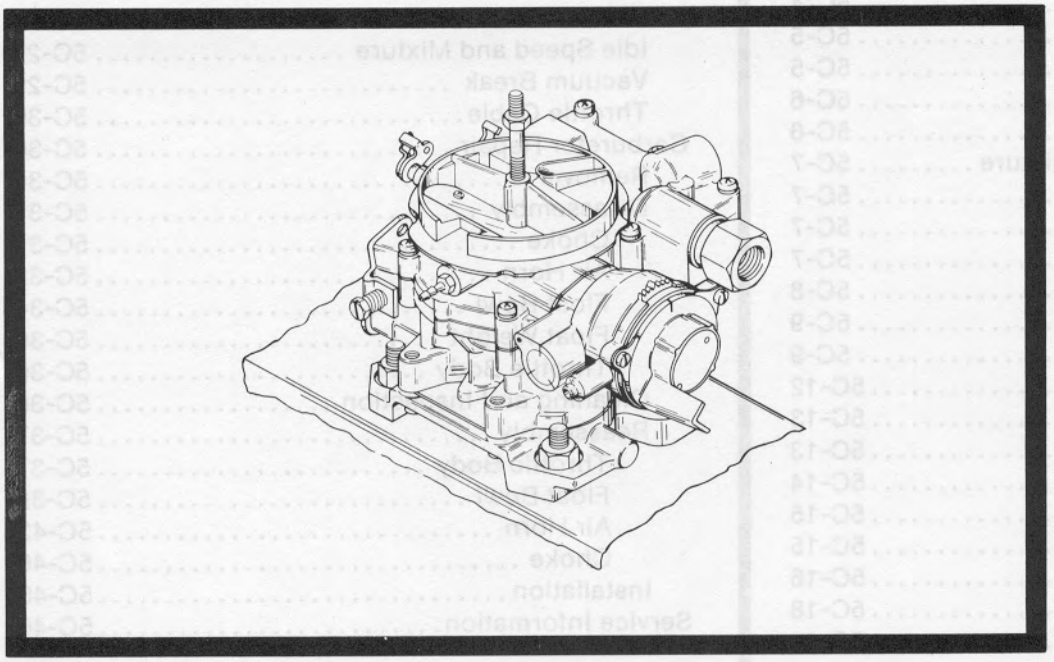
CLEANING and INSPECTION

1. Clean with solvent, blow off with compressed air.
2. Inspect pump for cracks and distortion.
3. Inspect arm and return spring for excessive wear or loose hinge pin.

INSTALLATION

1. Install fuel pump gasket and fuel pump, and torque to specifications.
2. Connect fuel lines to pump, and torque to specifications.
3. Start engine and check for leaks.

CARBURETION



CARBURETOR

5

C

mercruiser
STERN DRIVES & INBOARDS

INDEX

Page

Identification 5C-1
Mercarb™ - 2 Barrel 5C-1
Rochester - 4 Barrel 5C-1
Replacement Parts Warning 5C-1

MerCarb

Specifications 5C-2
Torque Specifications 5C-2
Special Tools 5C-2
Description 5C-3
Diagnosis 5C-3
Maintenance 5C-3
Changing Fuel Filter 5C-3
Cleaning Flame Arrestor and Crankcase Ventilation Hoses 5C-4
Adjustments 5C-4
Choke 5C-4
Choke Unloader 5C-5
Float Drop 5C-5
Float Level 5C-6
Pump Rod 5C-6
Preliminary Idle Speed and Mixture 5C-7
Throttle Cable 5C-7
Carburetor Repair 5C-7
Removal 5C-7
Disassembly 5C-8
Choke Housing 5C-9
Air Horn 5C-9
Float Bowl 5C-12
Float Weight 5C-13
Throttle Body 5C-13
Cleaning and Inspection 5C-14
Reassembly 5C-15
Throttle Body 5C-15
Float Bowl Assembly 5C-16
Air Horn Assembly 5C-18
Choke Housing Assembly 5C-21
Installation 5C-22

INDEX

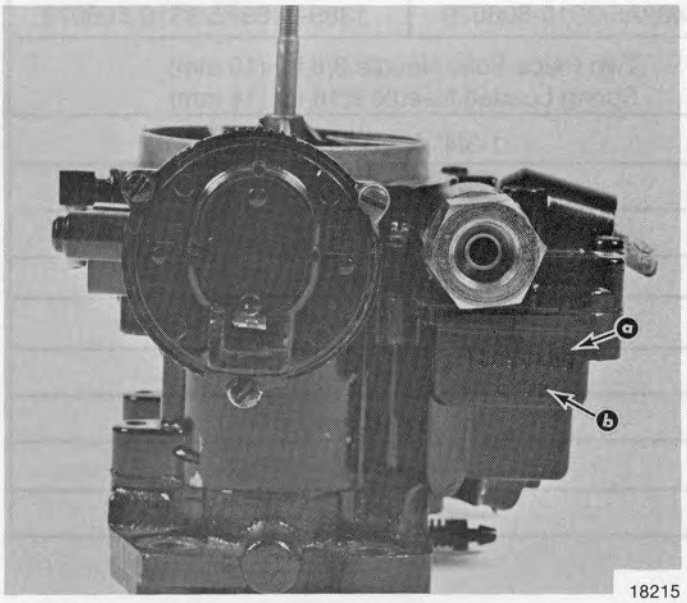
Rochester - 4MC

Page

Specifications 5C-22
Torque Specifications 5C-23
Special Tools 5C-23
Description 5C-24
Diagnosis 5C-24
Maintenance 5C-24
Changing Fuel Filter 5C-24
Cleaning Flame Arrestor and Crankcase Ventilation Hose 5C-25
Adjustments 5C-26
Accelerator Pump 5C-26
Air Valve Dashpot 5C-27
Air Valve Spring Windup 5C-27
Float Level 5C-28
Choke 5C-28
Idle Speed and Mixture 5C-29
Vacuum Break 5C-29
Throttle Cable 5C-30
Carburetor Repair 5C-30
Removal 5C-30
Disassembly 5C-31
Choke 5C-31
Air Horn 5C-32
Float Bowl 5C-34
Float Weight 5C-36
Throttle Body 5C-36
Cleaning and Inspection 5C-36
Reassembly 5C-37
Throttle Body 5C-37
Float Bowl 5C-38
Air Horn 5C-42
Choke 5C-46
Installation 5C-46
Service Information 5C-46

Identification

MERCARB - 2 BARREL

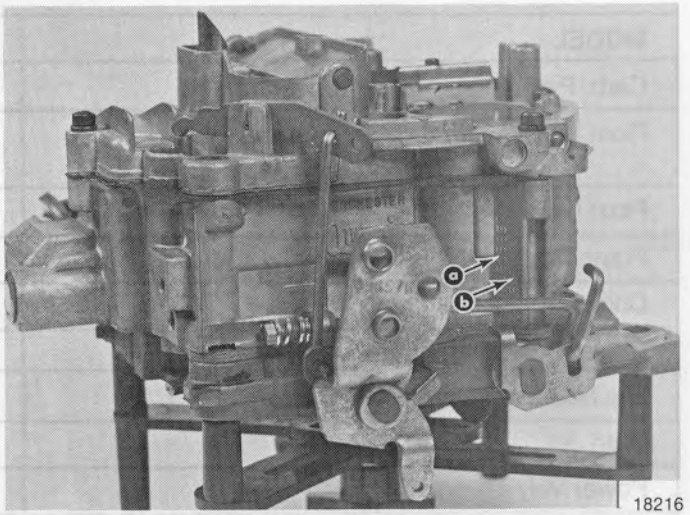


18215

a - Part Number
b - Date Code

Date Code Explanation: 4501
First Figure is Year
4 = 1984, 5 = 1985, etc.
Second Figure is Month
5 = May, 6 = June, 7 = July, etc.,
X = October, Y = November, Z = December
Third and Fourth Figure is Day of Month
01 = First day, 02 = Second day, etc.

ROCHESTER - 4 BARREL



18216

a - Part Number
b - Date Code

The part number is stamped on the throttle lever side above the secondary shaft.

REPLACEMENT PARTS

⚠WARNING

Fuel, ignition, and electrical system components are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement fuel, ignition, or electrical system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Specifications

MODEL	MCM 170	MCM 170
Carb. Part Number - Mercury Marine	1389-8489A5/3310-806079	1389-8489A5/3310-806079
Float Level (Note 2)	Two Piece Solid Needle 3/8 in. (10 mm) Spring Loaded Needle 9/16 in. (14 mm)	
Float Drop (Note 1)	1-3/4" (44.5 mm)	
Pump Rod	1-3/32 " (27 mm)	
Choke Setting	Index Marks	
Choke Unloader	.080" (5/64", 2 mm)	
Idle Mixture Preliminary Setting	1-1/4 Turn	
Main Jet	1.65 mm	
Power Valve	.9 mm	
Float Weight	9 grams	
Venturi Cluster I.D.	411	

All Measurements are ± 1/64" (.4mm)

NOTES:

1) Float Drop Measured From Air Horn (With Gasket in Place) to Toe of Float.
2) Fuel Inlet Needle Is Spring Loaded. Before Checking Float Level, Raise Float and Allow It to Fall (On Spring). DO NOT FORCE FLOAT DOWNWARD BY HAND.

Torque Specifications

FASTENER LOCATION	LBS. FT. (N.m)	LBS. IN. (N.m)
Nut - Carburetor to Manifold	20 (27)	
Fitting - Fuel Line to Carburetor	18 (24)	
Nut - Fuel Inlet Filter	18 (24)	
Remote Control Throttle Cable, Brass Barrel, Cable End Guide		Note 1

NOTE 1: Tighten, then back nut off 1/2 turn.

Special Tools

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

BORROUGHS TOOL and EQUIPMENT 2429 N. BURDICK ST. KALAMAZOO, MI 49007 (616) 345-5163	
BT 8128B	Float Gram Scale

Description

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are a fixed orifice type that work together with fixed air bleeds to properly meter the correct fuel/air mixture to the engine.

Diagnosis

The fuel system must maintain a fuel pressure of 3 to 7 lbs. to function properly. Before repairing or disassembly of the carburetor check the following:

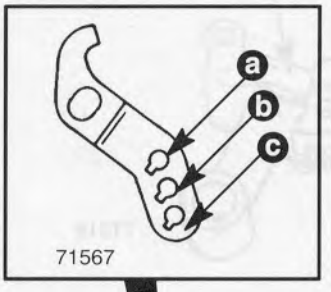
1. Sufficient amount of fuel in tank.
2. Tank correctly vented.
3. Check anti-siphon valve.
4. All filters in system are clean.
5. Proper fuel line routing (not kinked or pinched).
6. All fittings secure with no air or fuel leaks.
7. Operate throttle lever and observe that fuel is being injected into throttle bore.
8. Check choke to ensure full closure.
9. Check all air horn retaining screws for tightness.
10. Check carburetor retaining studs and bolts.

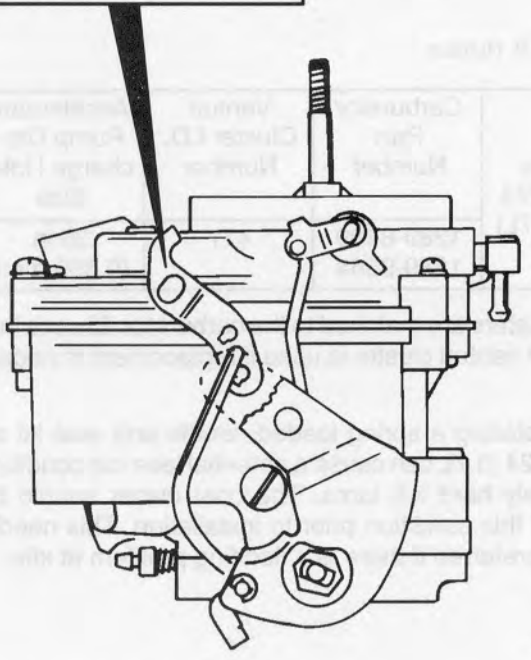
If problems continue refer to troubleshooting section.

Bogging Condition On Acceleration

There is a 3 hole accelerator pump lever (3302-823725) that can prevent this condition. Ensure that the accelerator pump well does not have metal ball to restrict pump travel and accelerator pump spring has not been cut. Also ensure the venturi cluster.

If installing on carburetor that has a single hole lever, install the rod in the in the middle hole. This will provide 0.5 cc less fuel to the engine on acceleration. Test boat in water to see id bog has been corrected. Rod can be moved to the other holes to richen or lean the carburetor if necessary.





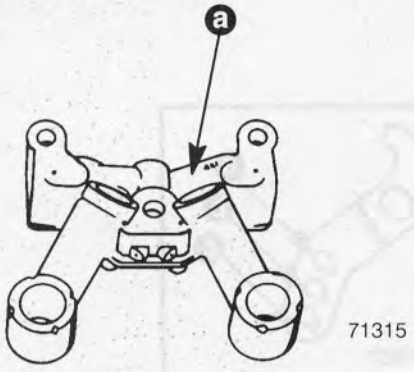
a - Full Accelerator Pump Stroke
b - 0.5cc Less Per Stroke
c - 1.0cc Less Per Stroke

Flooding at Idle RPM

If an engine is flooding at idle RPM, Check the following:

3. Problems in ignition system causing the engine to run rough.
4. Idle mixture screw adjusted incorrectly.
5. Bad needle and seat.
6. Incorrect float level or drop.

Venturi Cluster Identification



a - Cluster I.D. Number

Mercury Marine 224 C.I.D. (3.7L)	Carburetor Part Number	Venturi Cluster I.D. Number	Accelerator Pump Discharge Hole Size
	1389-8489 1389-9564	411	.35 in. (0.889 mm)

Venturi clusters are matched to the carburetor. Ensure that the correct venturi cluster is used if replacement is necessary.

NOTE: Installing a spring loaded needle and seat kit on Mercury 224 (3.7L can cause a potential lean out condition in extremely hard left turns. The boat owner should be warned of this condition prior to installation. This needle and seat preferred if there is a flooding problem at idle.

Maintenance

CHANGING FUEL FILTER

⚠WARNING

Be careful when changing fuel filter; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

1. Remove:
   a. Fuel line from fuel inlet filter nut
   b. Fuel inlet filter nut
   c. Large gasket
   d. Filter
   e. Spring
   f. Small gasket - From inside filter nut
2. Clean filter nut and spring in solvent and dry with compressed air.

a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

3. Install in the following order:
   a. Spring - Place in carburetor body
   b. Filter - Open end to inlet filter nut
   c. Small gasket - Place inside filter nut
   d. Large gasket - Place over filter nut
   e. Fuel inlet filter nut - Tighten to specifications
   f. Fuel line - Tighten to specifications

⚠WARNING

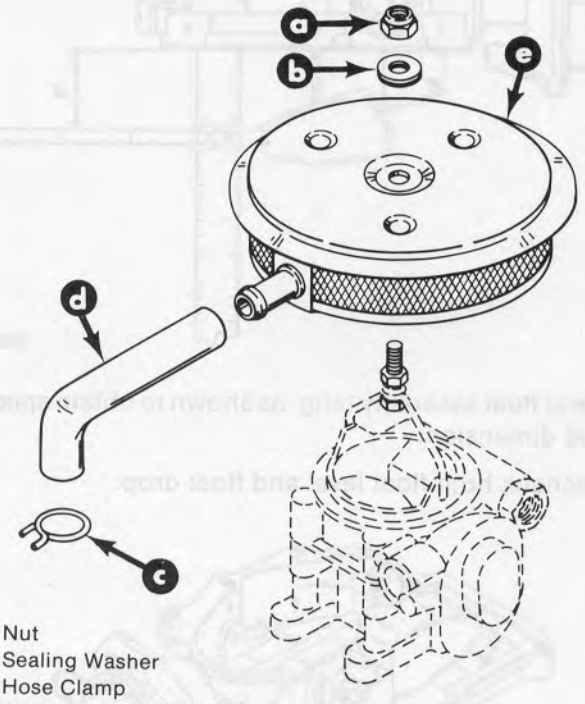
Make sure no fuel leaks exist, before closing engine hatch.

CLEANING FLAME ARRESTOR and CRANKCASE VENTILATION HOSES

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

1. Remove:
   a. Nut
   b. Sealing washer
   c. Hose clamp and crankcase ventilation hose
   d. Flame arrestor
2. Clean and inspect:
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Crankcase ventilation hose.
   c. Inspect crankcase ventilation hose for cracks or deterioration. Replace if necessary.



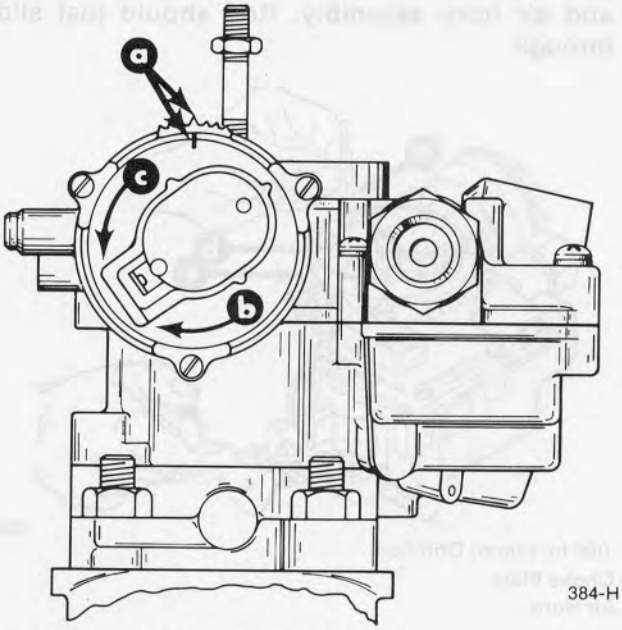
a - Nut
b - Sealing Washer
c - Hose Clamp
d - Crankcase Ventilation Hose
e - Flame Arrestor

3. Install in the following order:
   a. Flame Arrestor
   b. Crankcase ventilation hose and hose clamp
   c. Sealing washer
   d. Nut - Tighten securely

Adjustments

CHOKE

Normal choke setting is such that scribed mark on cover is in line with long case mark on choke housing.



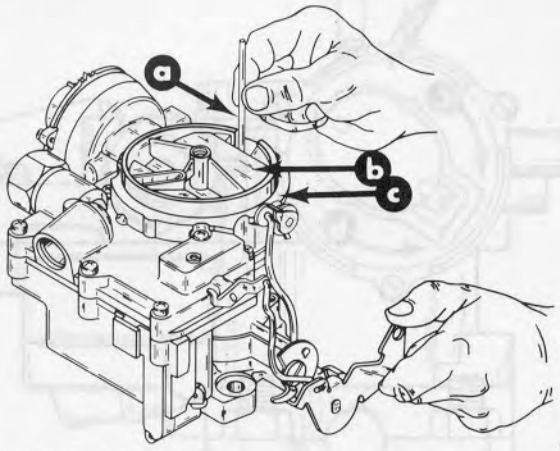
a - Marks on Choke Cover and Choke Housing
b - Leaner
c - Richer

If choke adjustment is necessary:

1. Loosen 3 retaining screws.
2. Turn cover one mark at-a-time.
3. Tighten 3 retaining screws securely.

CHOKE UNLOADER

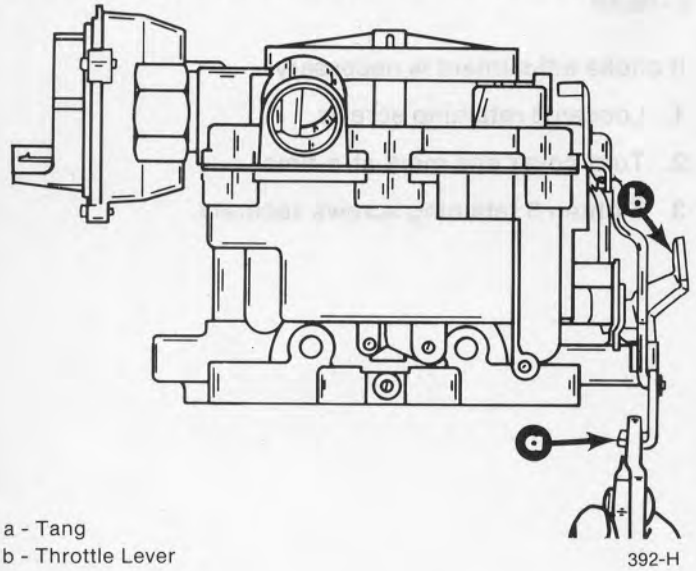
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. (2mm) drill rod, or appropriate gauge, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



392-H

a - .080 In. (2mm) Drill Rod
b - Choke Plate
c - Air Horn

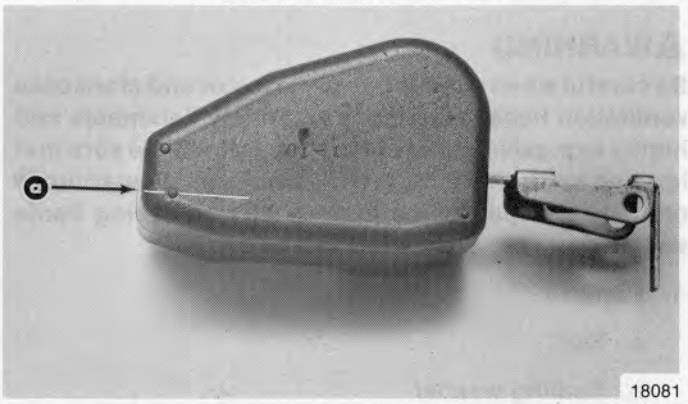
4. Bend tang on throttle lever to specified dimension.



a - Tang
b - Throttle Lever

392-H

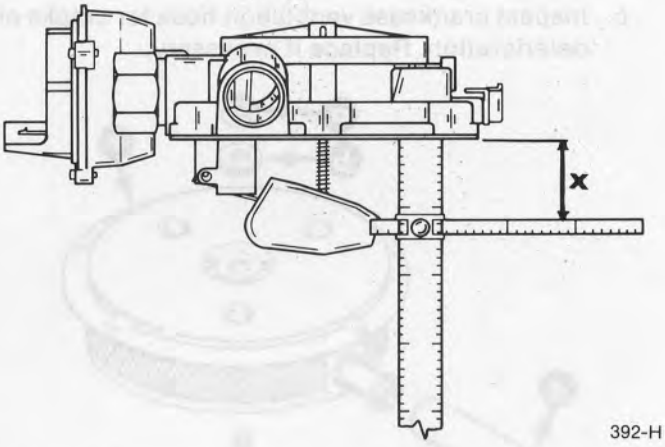
FLOAT DROP



18081

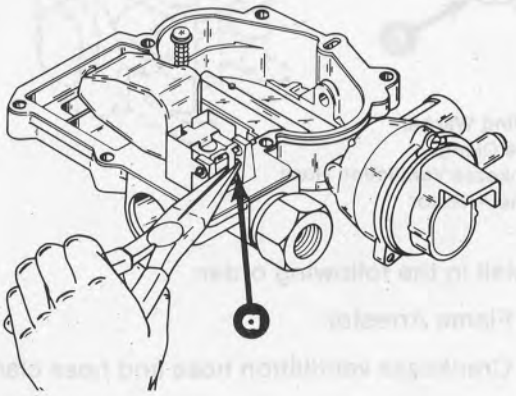
a - Measure from This Point to Gasket Surface

1. Hold air horn right-side-up to allow float to hang free. Air horn gasket must be in place.
2. Using Universal Carburetor Gauge (91-36392), measure from surface of gasket to toe of float per specifications.



392-H

3. Bend float assembly tang, as shown to obtain specified dimension.
4. Recheck both float level and float drop.



392-H

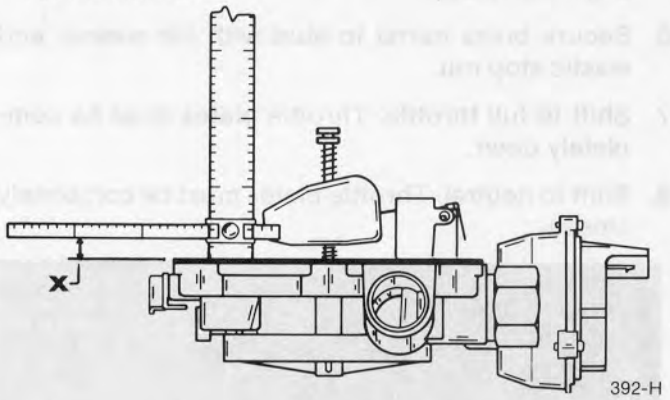
a - Float Assembly Tang

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly to ensure free movement. Air horn gasket must be in place.

IMPORTANT: Before checking float level, raise float and allow it to fall (on spring); however, DO NOT FORCE DOWNWARD BY HAND.

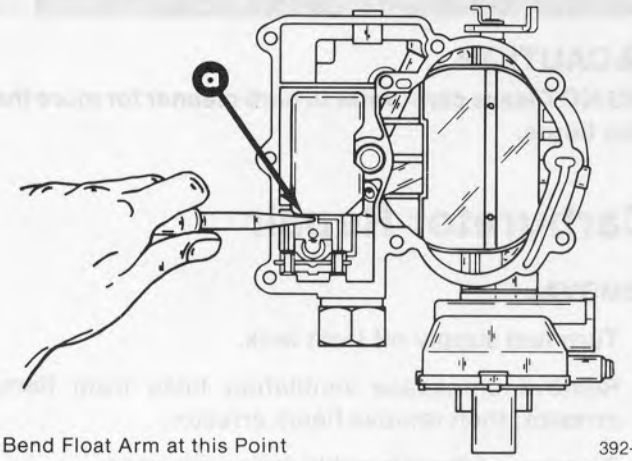
2. Using Universal Carburetor Gauge (91-36392), measure from surface of gasket to toe of float per specifications.



392-H

IMPORTANT: DO NOT put pressure on needle assembly when bending float arm (in the following step), as needle tip could be damaged.

3. Bend float arm up or down at point shown to obtain specified dimension.
4. Visually check float alignment after adjustment.

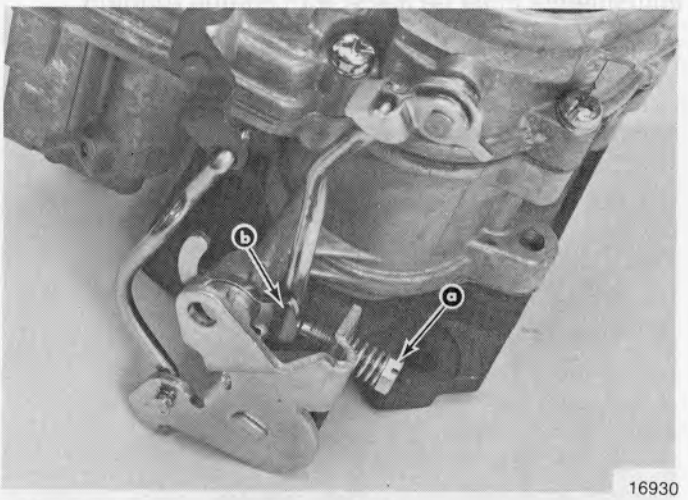


a - Bend Float Arm at this Point

392-H

PUMP ROD

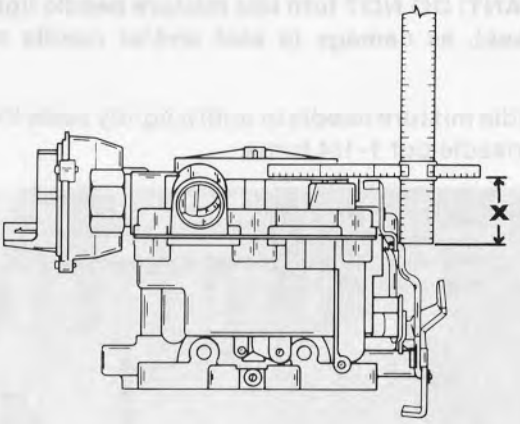
1. Back out idle speed screw until it no longer contacts idle cam.



16930

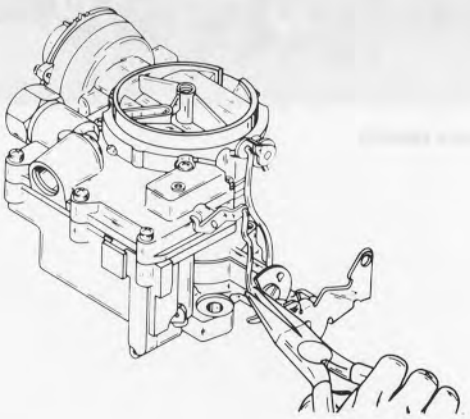
a - Idle Speed Screw
b - Idle Cam

2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod, per specifications.



392-H

3. Carefully bend pump rod (where shown) to obtain specified dimension.

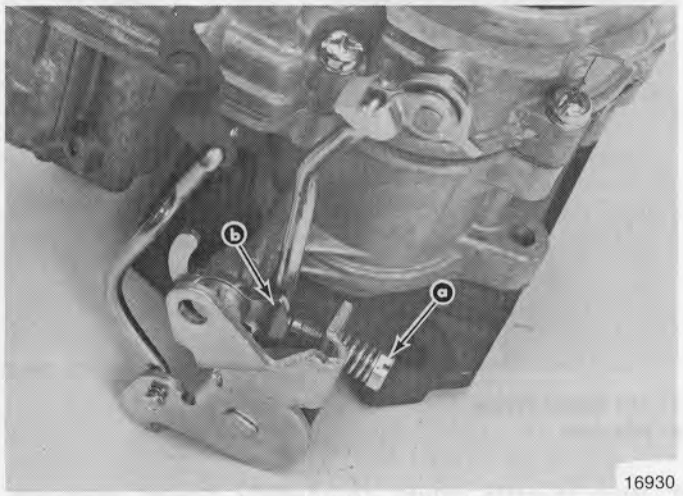


392-H

PRELIMINARY IDLE SPEED and MIXTURE

NOTE: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Turn idle speed screw in until it just contacts idle cam; then, turn screw in an additional two turns.

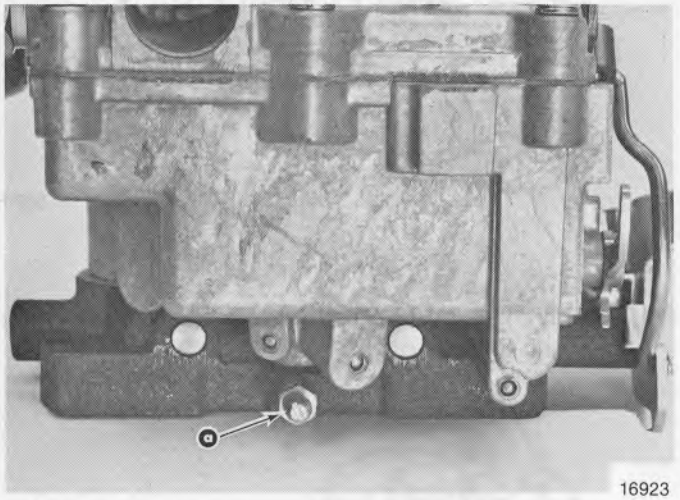


16930

a - Idle Speed Screw
b - Idle Cam

IMPORTANT: DO NOT turn idle mixture needle tightly against seat, as damage to seat and/or needle may result.

2. Turn idle mixture needle in until it lightly seats then, back needle out 1-1/4 turns.

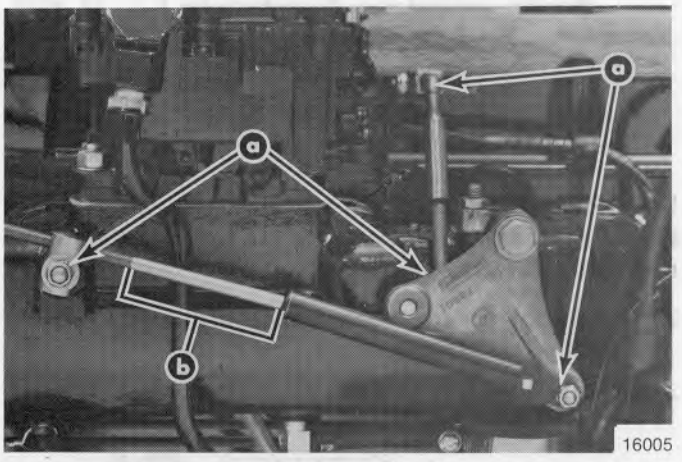


16923

a - Idle Mixture Needle

THROTTLE CABLE

1. Place remote control in neutral.
2. Lubricate anchor studs at carburetor.
3. Install cable end guide, flat washer and elastic stop nut onto anchor stud.
4. Grasp cable behind brass barrel and push lightly to align barrel to anchor stud.
5. Adjust barrel by turning in direction required to align with stud.
6. Secure brass barrel to stud with flat washer and elastic stop nut.
7. Shift to full throttle. Throttle plates must be completely open.
8. Shift to neutral. Throttle plates must be completely closed.



16005

⚠CAUTION

DO NOT leave carburetor in carb cleaner for more than two hours.

Carburetor Repair

REMOVAL

1. Turn fuel supply off from tank.
2. Remove crankcase ventilation hose from flame arrestor, then remove flame arrestor.
3. Disconnect throttle cable from carburetor.
4. Remove fuel line from fuel inlet nut.
5. Remove fuel pump vent hose from carburetor.
6. Disconnect electric choke connections from choke cover.
7. Remove carburetor attaching nuts, washers and carburetor.
8. Remove and discard gaskets.

IMPORTANT: Place a cloth over intake manifold opening to prevent material from entering.

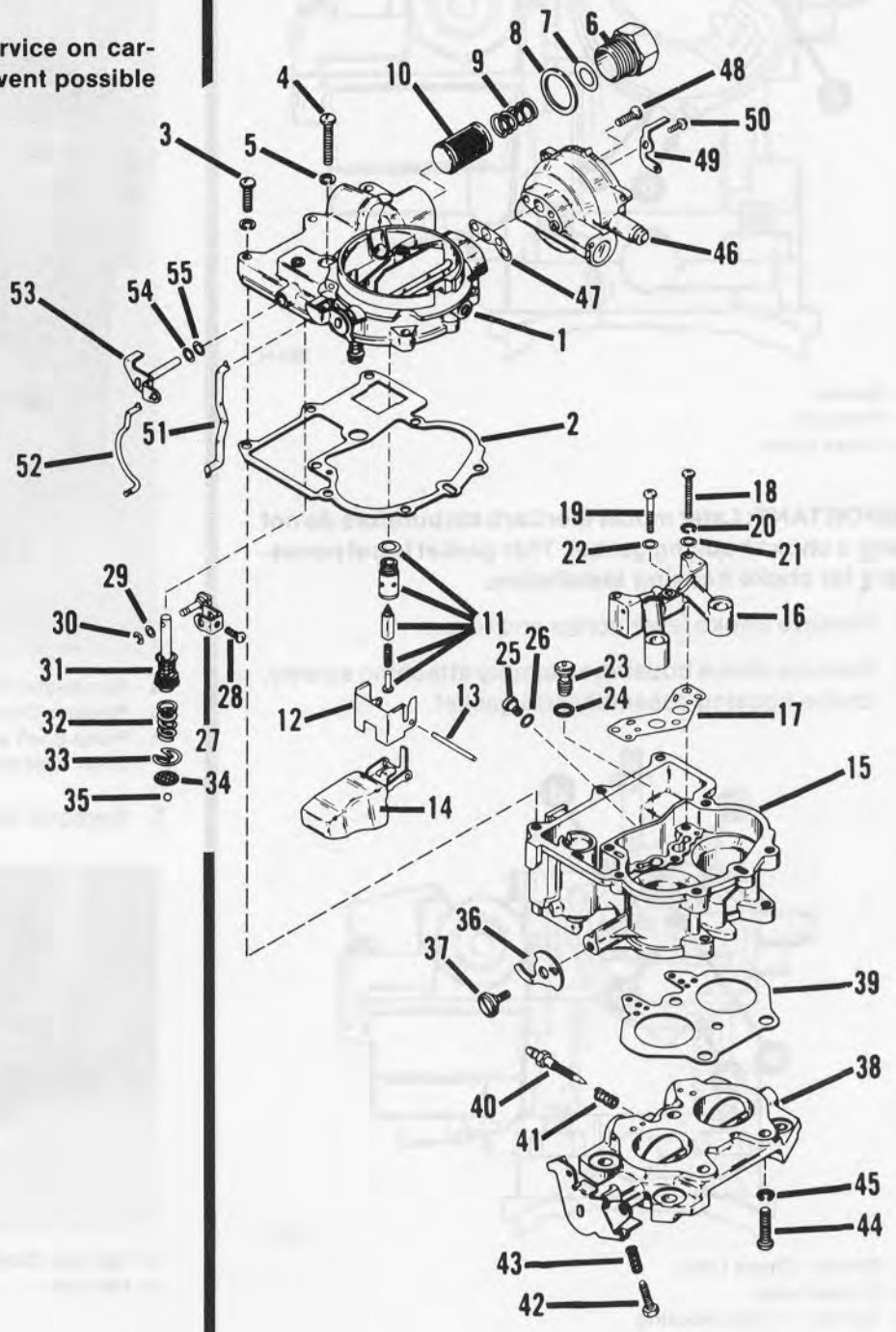
NOTICE
Refer to "Adjustments" for adjustments made during reassembly.

DISASSEMBLY

The following is a procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, only the steps required to repair the carburetor malfunction should be performed.

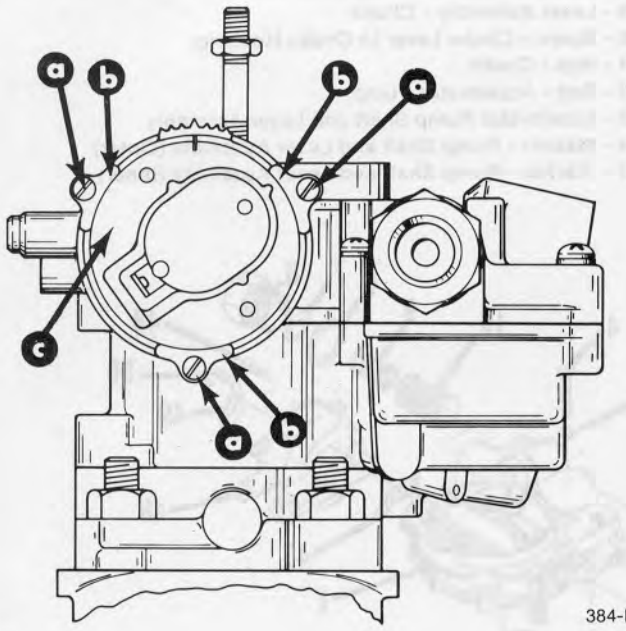
IMPORTANT: Before performing any service on carburetor, place in a holding fixture to prevent possible damage to throttle valves.

1 - Air Horn Assembly
2 - Gasket - Air Horn
3 - Screw - Air Horn (Short)
4 - Screw - Air Horn (Long)
5 - Lockwasher - Air Horn Screw
6 - Nut - Fuel Inlet
7 - Gasket - Fuel Inlet (Small)
8 - Gasket - Fuel Inlet (Large)
9 - Spring - Fuel Inlet
10 - Filter - Fuel Inlet
11 - Inlet Needle and Seat
12 - Baffle Plate
13 - Pin - Float Hinge
14 - Float Assembly
15 - Float Bowl Assembly
16 - Venturi Cluster Assembly
17 - Gasket - Venturi Cluster
18 - Screw - Venturi Cluster (Outer)
19 - Screw - Venturi Cluster (Inner)
20 - Lockwasher - Outer Venturi Cluster Screw
21 - Gasket - Outer Venturi Cluster Screw
22 - Gasket - Inner Venturi Cluster Screw
23 - Power Valve Assembly (Float Bowl)
24 - Gasket - Power Valve
25 - Jet (Float Bowl)
26 - Gasket - Jet
27 - Pump Shaft and Lever Assembly
28 - Screw - Air Horn Pump Lever
29 - Washer - Pump Shaft and Lever Assembly
30 - Clip - Retainer (Pump Rod)
31 - Accelerator Pump Assembly
32 - Spring - Pump Return (Float Bowl)
33 - Clip - Retainer (Check Ball)
34 - Strainer
35 - Check Ball
36 - Cam - Idle
37 - Screw - Idle Cam (Float Bowl)
38 - Throttle Body Assembly
39 - Gasket - Throttle Body
40 - Idle Mixture Adjusting Needle
41 - Spring - Idle Mixture Adjusting Needle
42 - Screw - Idle Speed Adjusting
43 - Spring - Idle Speed Adjusting Screw
44 - Screw - Throttle Body to Float Bowl
45 - Lockwasher - Throttle Body Screw
46 - Choke/Housing Assembly
47 - Gasket - Choke Housing
48 - Screw - Choke Housing to Air Horn
49 - Lever Assembly - Choke
50 - Screw - Choke Lever to Choke Housing
51 - Rod - Choke
52 - Rod - Accelerator Pump
53 - Accelerator Pump Shaft and Lever Assembly
54 - Washer - Pump Shaft and Lever Assembly (Outer)
55 - Washer - Pump Shaft and Lever Assembly (Inner)



Choke Housing

1. Remove choke cover screws, ground terminal and choke cover.

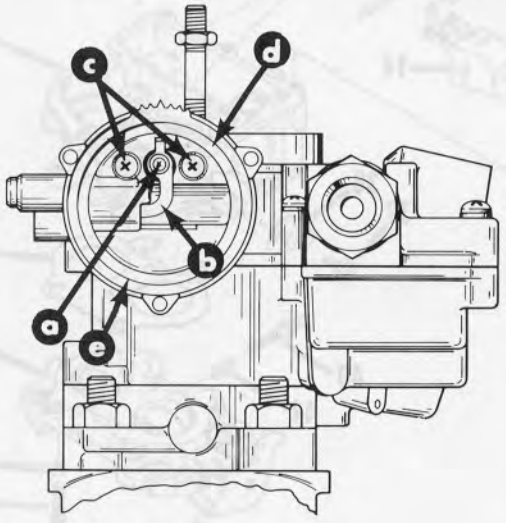


384-H

a - Screws
b - Retainers
c - Choke Cover

IMPORTANT: Later model MerCarb carburetors do not have a choke housing gasket. This gasket is not necessary for choke housing installation.

2. Remove choke lever screw and lever.
3. Remove choke housing assembly attaching screws, choke housing assembly and gasket.

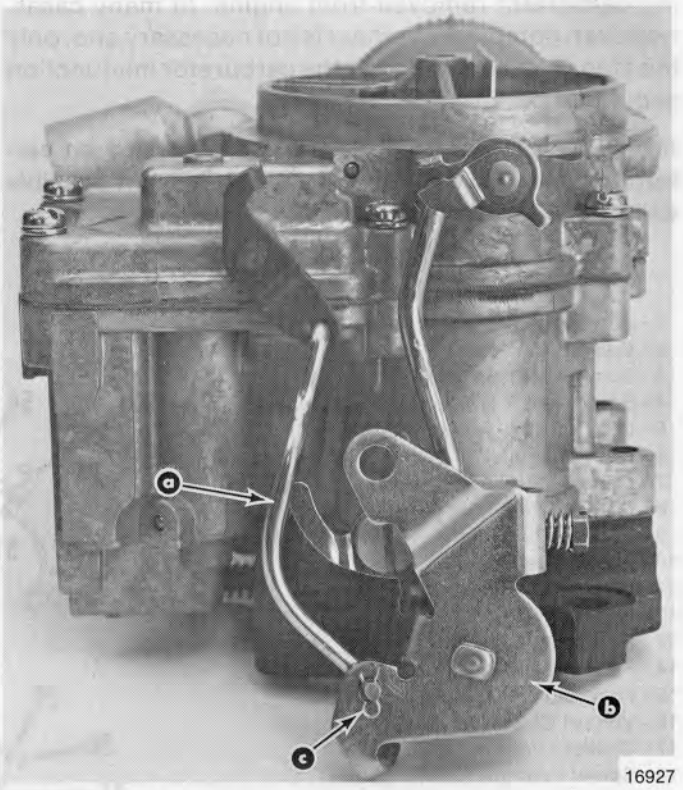


384-H

a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing
d - Gasket (If Equipped)
e - Choke Housing

Air Horn

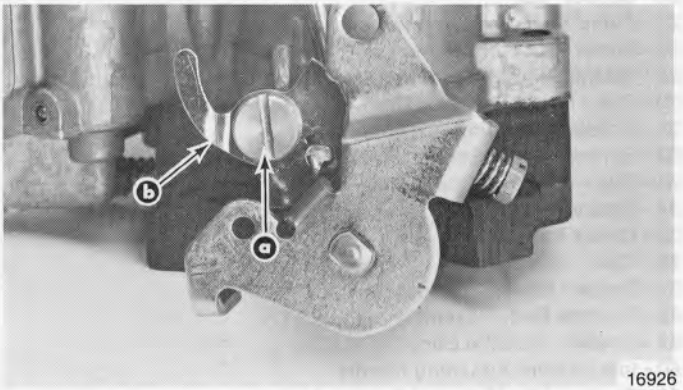
1. Remove fuel inlet filter nut, washers, spring, and filter.
2. Remove accelerator pump rod retaining clip. Pivot rod until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



16927

a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

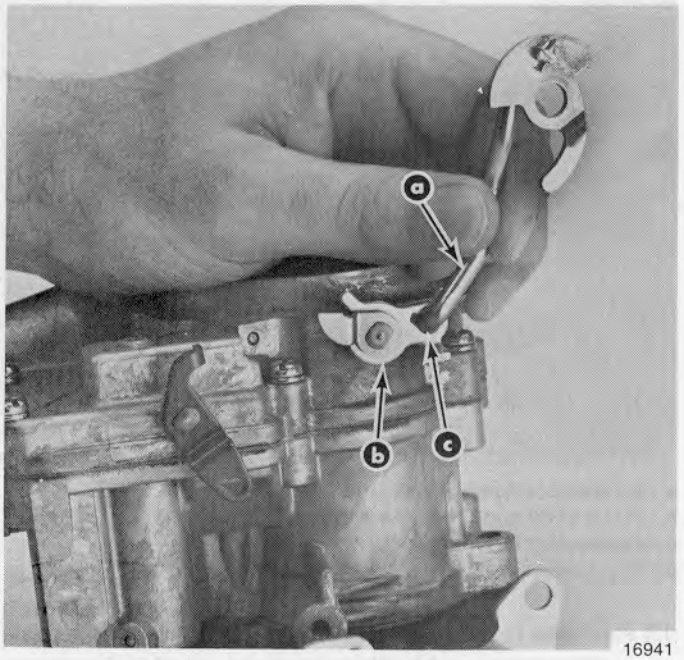
3. Remove idle cam screw.



16926

a - Idle Cam Screw
b - Idle Cam

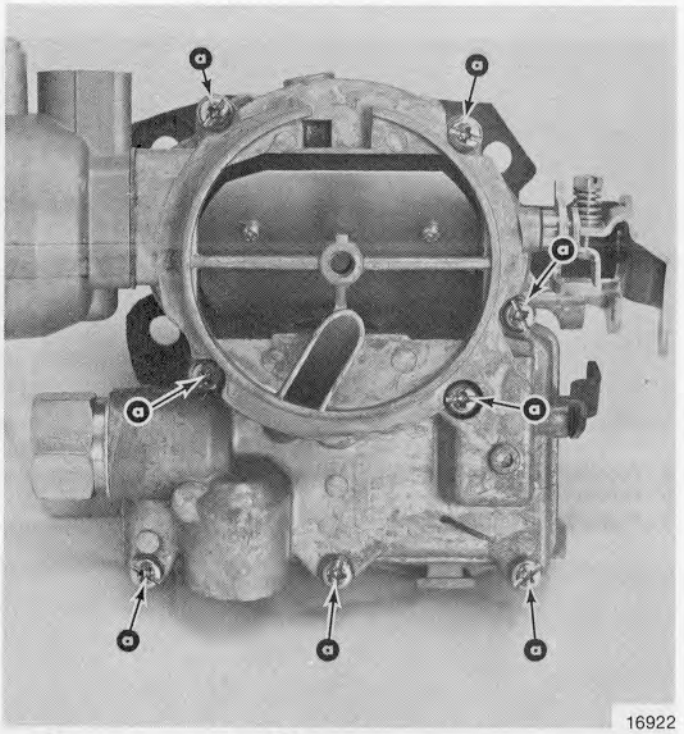
4. Remove choke rod.



16941

a - Choke Rod
b - Choke Lever
c - Slot

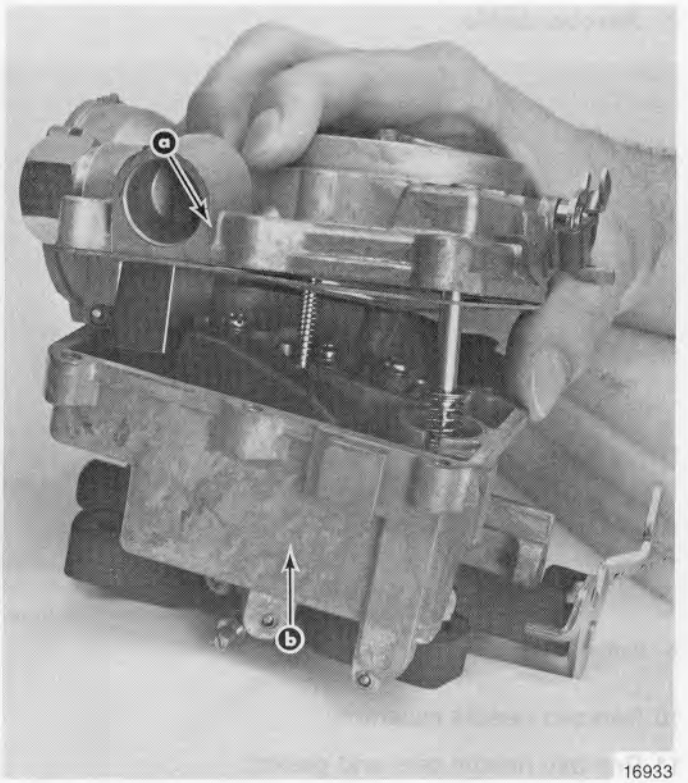
5. Remove air horn attaching screws and washers.



16922

a - Air Horn Attaching Screws

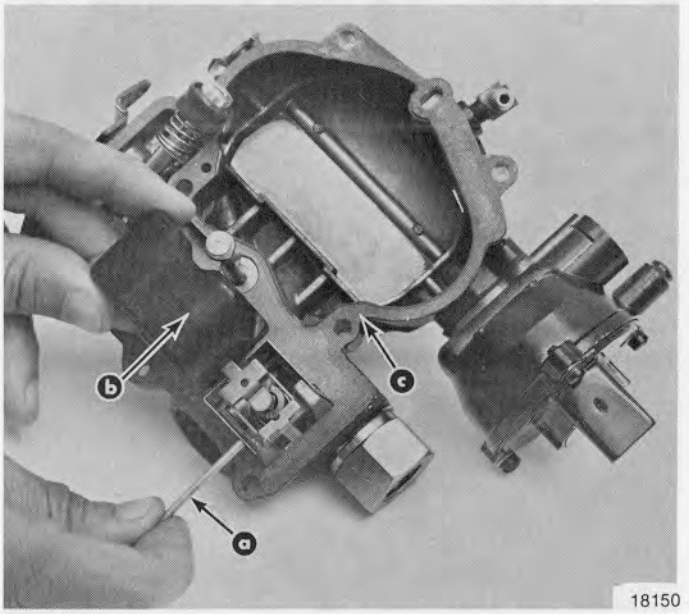
6. Lift air horn from float bowl assembly.



16933

a - Air Horn
b - Float Bowl Assembly

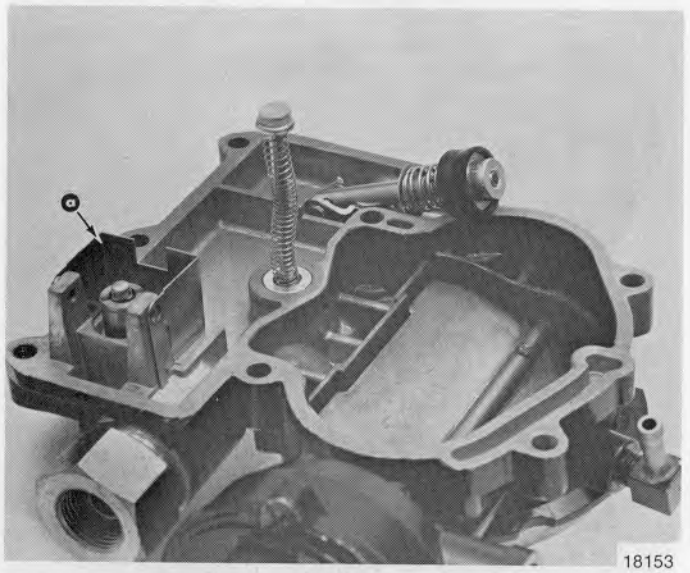
7. Remove float hinge pin and lift float assembly from air horn.



18150

a - Float Hinge Pin
b - Float Assembly
c - Air Horn Gasket

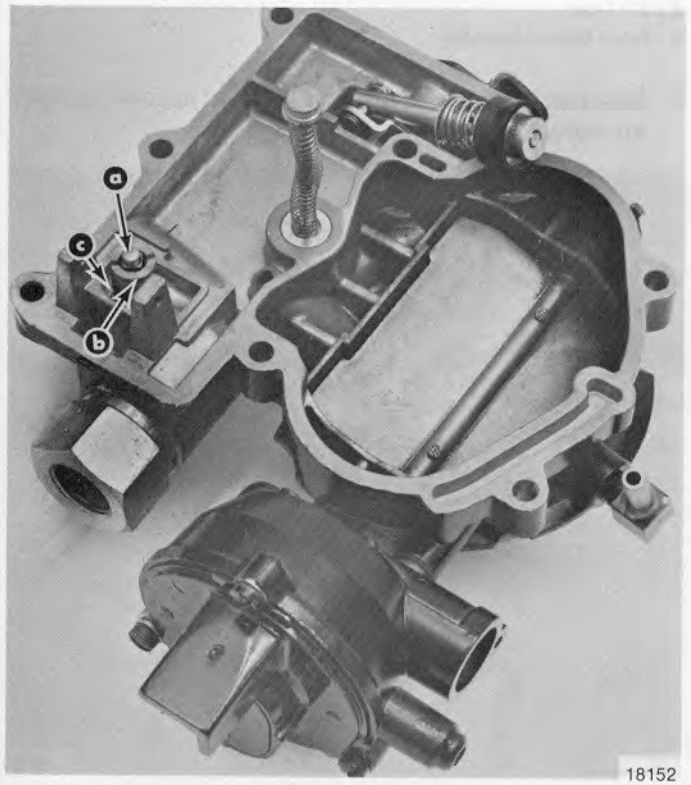
8. Remove air horn gasket.
9. Remove baffle.



18153

a - Baffle

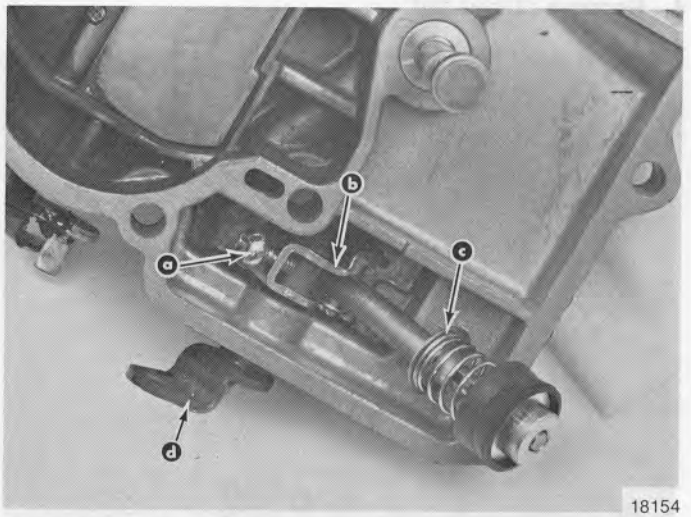
10. Remove needle assembly.
11. Remove needle seat and gasket.



18152

a - Needle Assembly
b - Needle Seat
c - Gasket

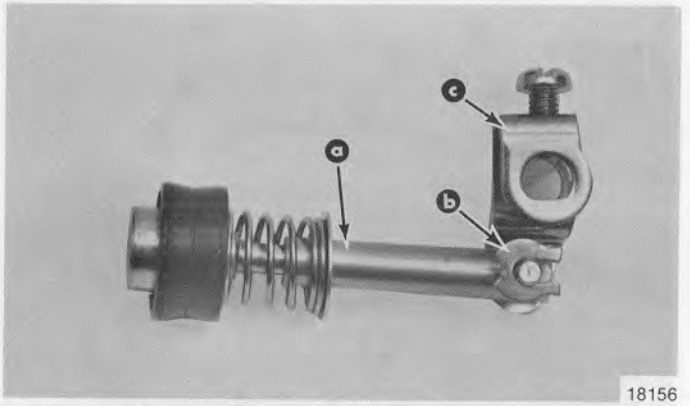
12. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn; then, remove accelerator pump assembly and pump lever.



18154

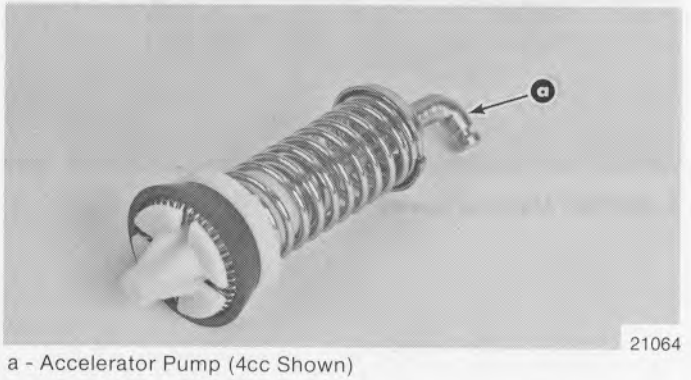
a - Accelerator Pump Screw
b - Pump Shaft and Lever Assembly
c - Accelerator Pump Assembly (2cc Shown)
d - Pump Lever

13. Remove retainer clip and washer from pump shaft and lever assembly; then, remove accelerator pump assembly.



18156

a - Accelerator Pump Assembly (2cc Shown)
b - Retainer Clip
c - Pump Shaft and Lever Assembly



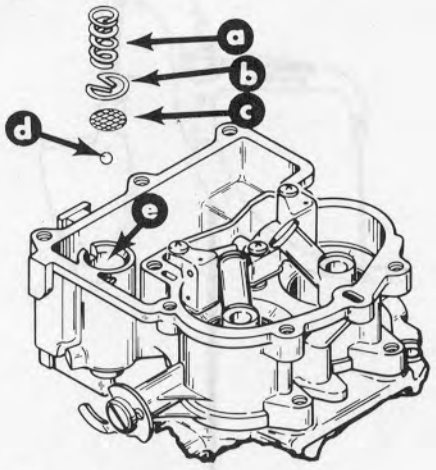
21064

a - Accelerator Pump (4cc Shown)

NOTE: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

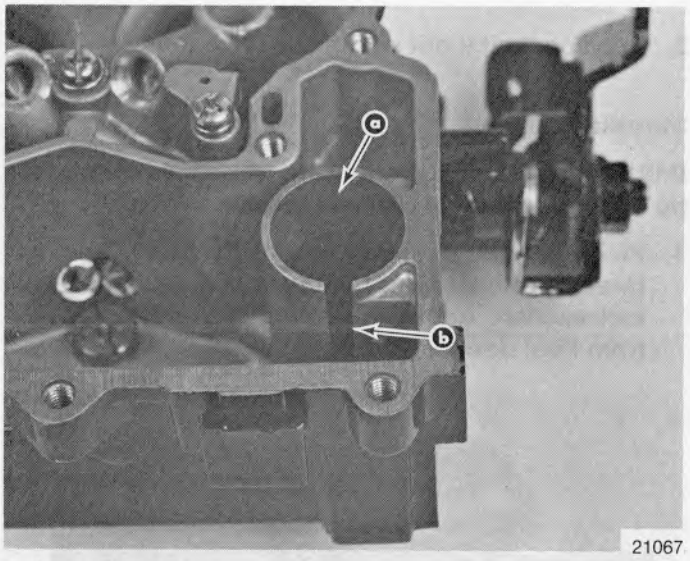
Float Bowl

1. Remove accelerator pump return spring from pump well.
2. Remove retainer clip, strainer, and check ball from pump well.



392-H

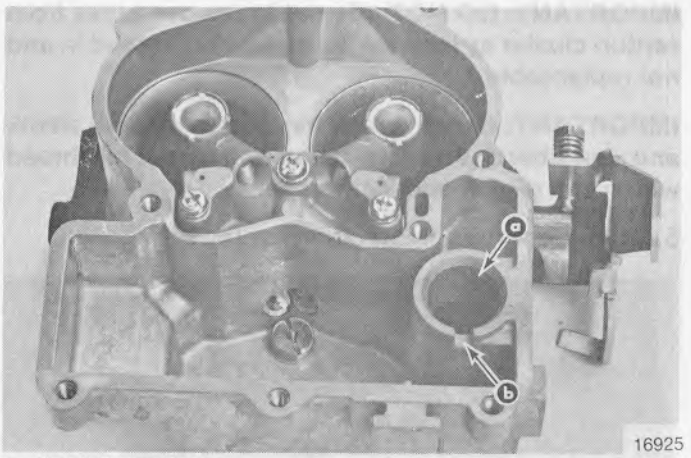
a - Accelerator Pump Return Spring
b - Retainer Clip
c - Strainer
d - Check Ball
e - Pump Well
(2cc Pump Only)



21067

a - Large Pump Bore
b - Long Groove

Float Bowl Assembly for 4cc Accelerator Pump

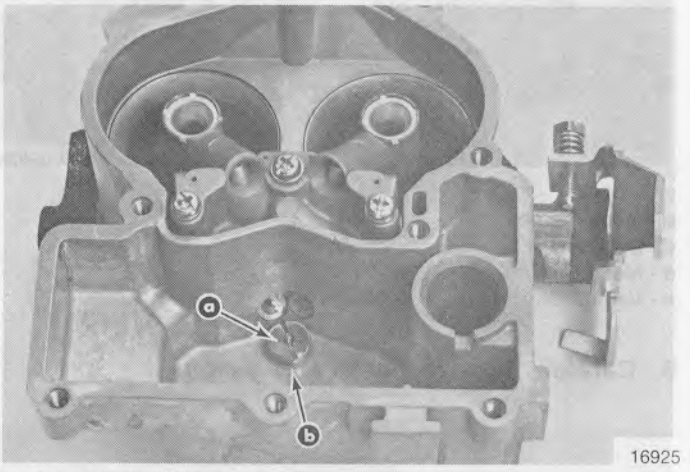


16925

a - Small Pump Bore
b - Short Groove

Float Bowl Assembly for 2cc Accelerator Pump

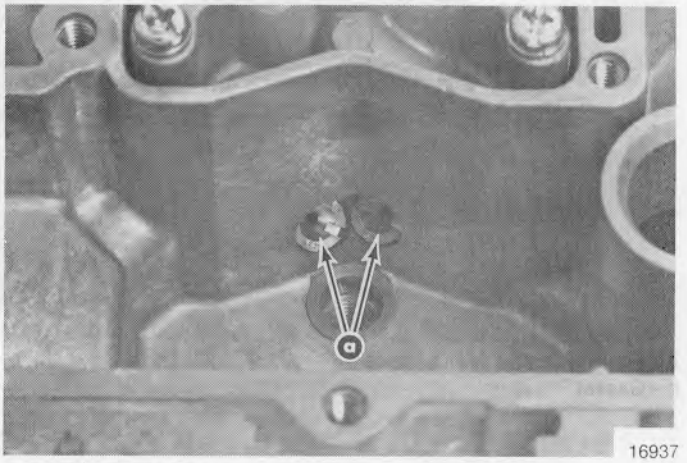
3. Remove power valve assembly and gasket.



16925

a - Power Valve Assembly
b - Gasket

4. Remove main metering jets and metal gaskets.



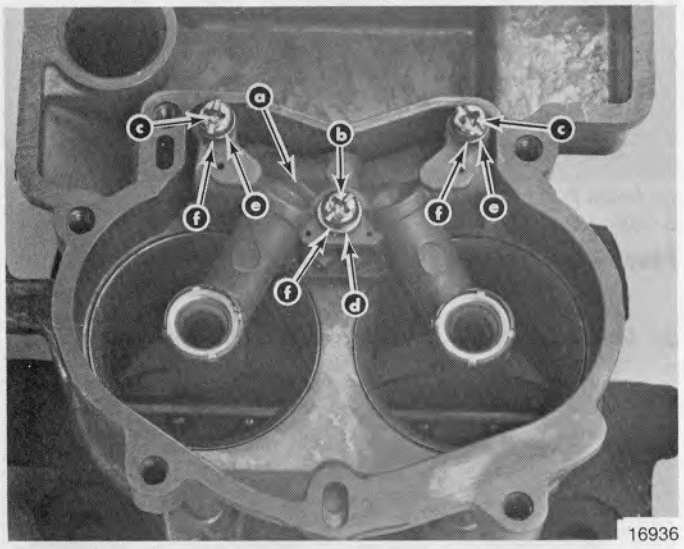
16937

a - Main Metering Jets

IMPORTANT: DO NOT attempt to remove tubes from venturi cluster as they are permanently pressed in and not replaceable.

IMPORTANT: Center screw has partial smooth shank and uses fiber and metal washer. End screw, full thread with metal gasket and lockwasher.

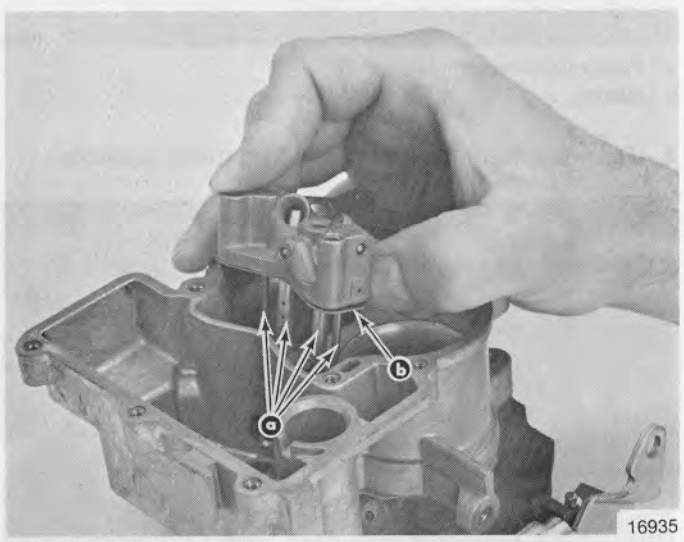
5. Remove three venturi cluster screws.



16936

a - Screws
b - Fiber Washer
c - Lockwashers
d - Metal Gaskets
e - Venturi Cluster

6. Carefully remove cluster and gasket.

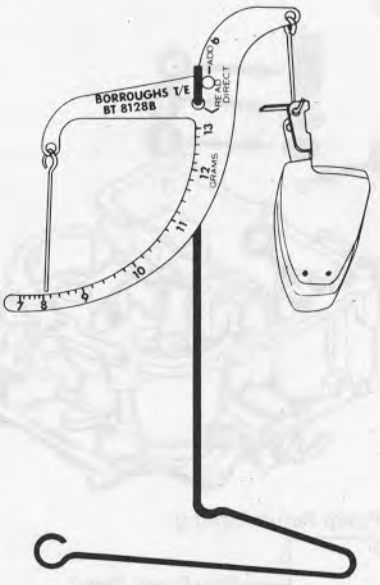


16935

a - Venturi Cluster Brass Tubes
b - Gasket

Float Weight

1. Assemble float scale to instructions with scale.
2. Check float weight with scale.



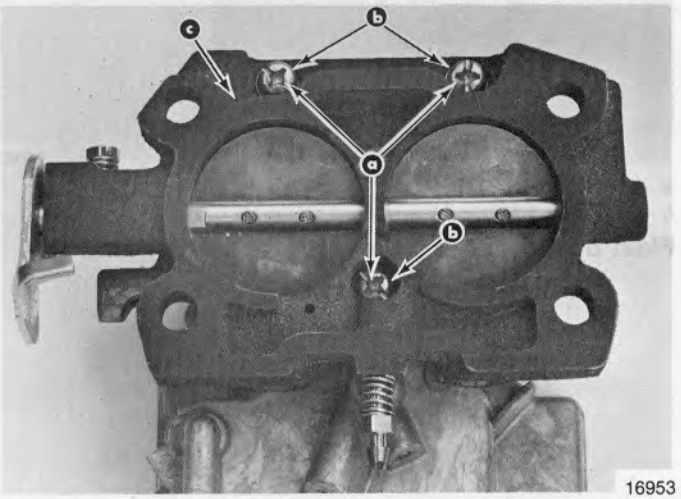
a - Float Scale
b - Float

3. Replace float if not within specifications.

Throttle Body

IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

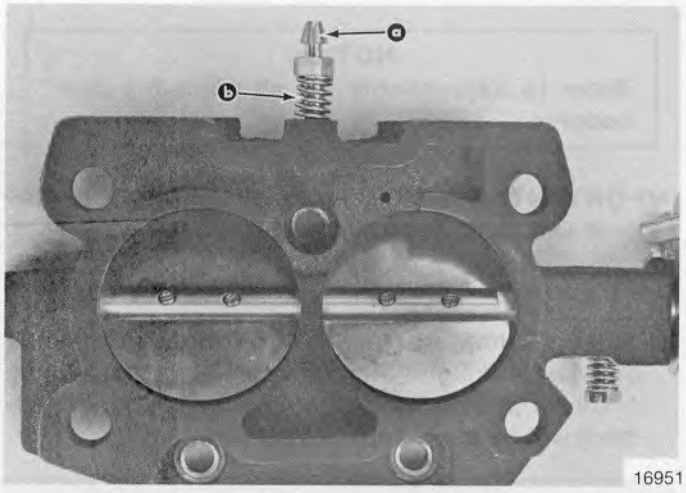
1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl.



16953

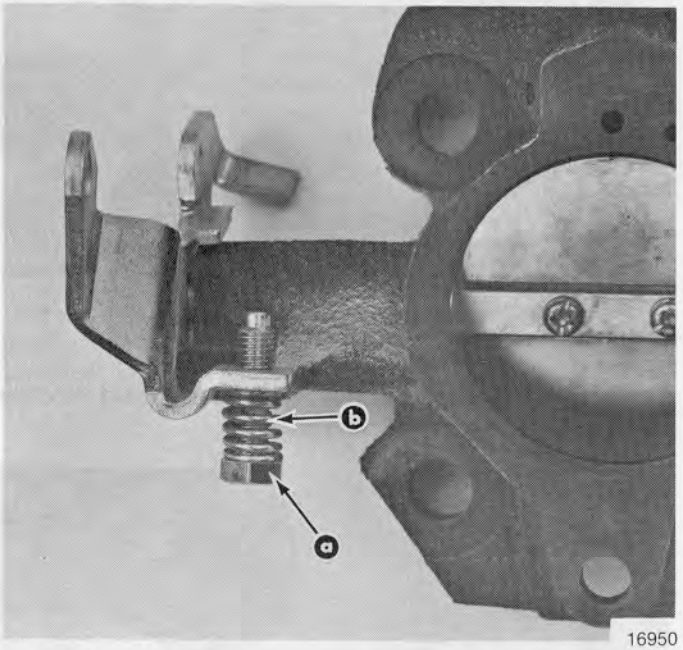
a - Screws
b - Lockwashers
c - Throttle Body

2. Remove idle mixture adjusting needle and spring.



a - Idle Mixture Adjusting Needle
b - Spring

3. Remove idle speed screw and spring, if replacement is necessary.



a - Idle Speed Screw
b - Spring

⚠CAUTION

If any of throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

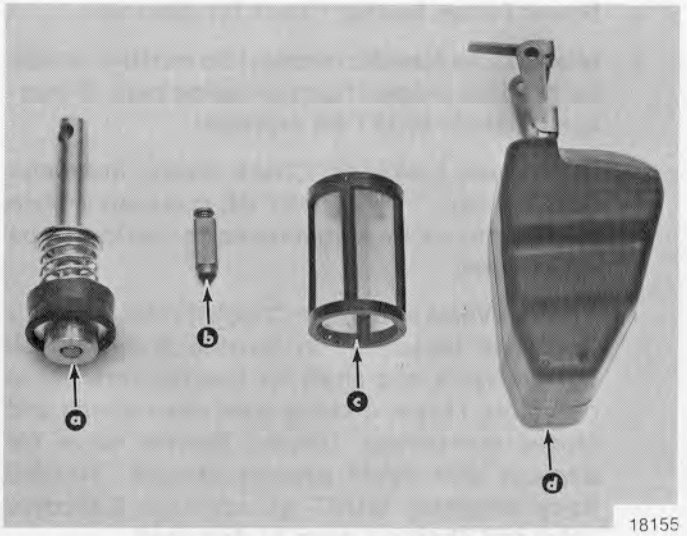
CLEANING and INSPECTION

Observe the following cleaning and inspection procedure, to obtain effective carburetor repair.

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

IMPORTANT: The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



a - Accelerator Pump Plunger (2cc Shown)
b - Needle
c - Fuel Filter
d - Float

1. Clean all metal parts in a carburetor cleaner. Follow manufacturer's instructions of cleaner. Dry with compressed air.
2. Blow out all passages in carburetor to remove any foreign material.
3. Wipe-off parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Inspect carburetor parts for wear and damage;
   a. **Float Needle and Seat:** Inspect float needle tip and seat for damage that could prevent a good seal. If worn or damaged, replace.

IMPORTANT: Float needle and seat are matched and should be replaced as a set only.

b. **Float Assembly and Hinge Pin:** Inspect float pontoon for deterioration and porosity. Check pontoon weight per specifications. Inspect surface where float needle contacts float arm and replace float assembly if grooved. Check hinge pin and holes for wear.

c. **Fuel and Air Passages:** Inspect jets, orifices, tubes, and nozzles for physical damage. Check fuel and air passages for blockage by squirting solvent thru each. Passages MUST BE perfectly clean for proper carburetor operation.

d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup for wear, cracks, or hardness. Check pump plunger spring for distortion.

e. **Power Piston Spring:** Check for distortion.

f. **Idle Mixture Needle:** Inspect idle mixture needle for grooves, ridges, burrs, or being bent. If damaged, needle MUST BE replaced.

g. **Levers and Linkages:** Check levers, links and rods for wear. Parts MUST BE replaced if worn to the point where adjustments can no longer be maintained.

h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Inspect throttle valve for damage that could prevent closure. Throttle body assembly MUST BE replaced if throttle valve and shaft are worn or damaged.

i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding thru entire operating range, making sure valve opens and closes completely. Inspect choke valve for damage that could prevent proper closure. Air horn assembly MUST BE replaced if choke valve and shaft and lever assembly are worn or damaged.

j. **Inspect casting** for visible damage. Inspect gasket surfaces for damage that will prevent sealing. Inspect accelerator pump plunger well for scoring or deposits.

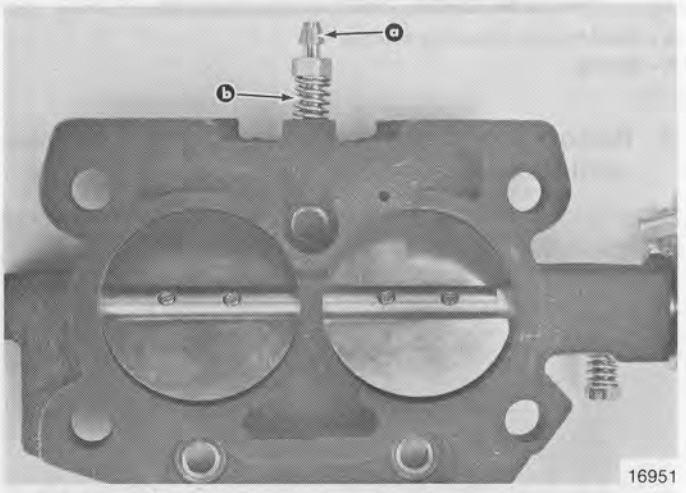
REASSEMBLY

NOTICE
Refer to adjustments for all adjusting procedures.

IMPORTANT: DO NOT force idle mixture needle against seat as damage will result.

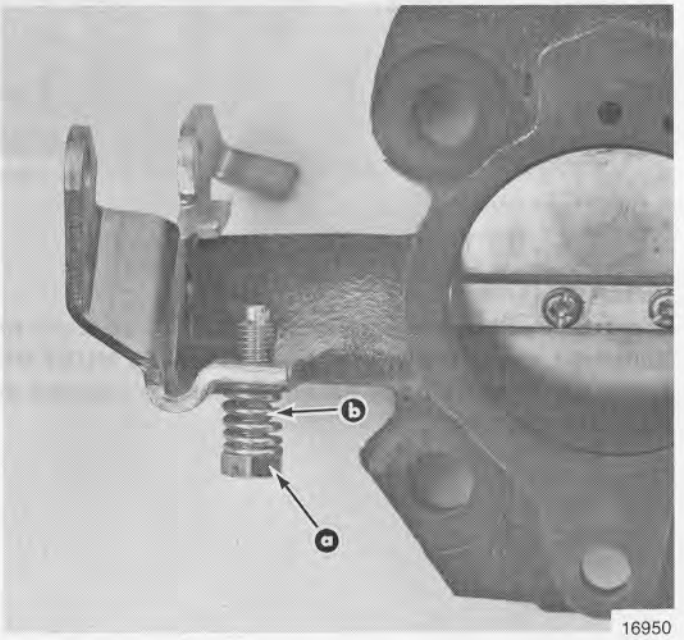
Throttle Body

1. Screw idle mixture needle (with spring) into throttle body until it lightly seats; then, back out needle 1-1/4 turns as a preliminary setting. Final adjustment will be made with engine running.



a - Idle Mixture Needle
b - Spring

2. Thread idle speed screw, with spring into throttle lever.

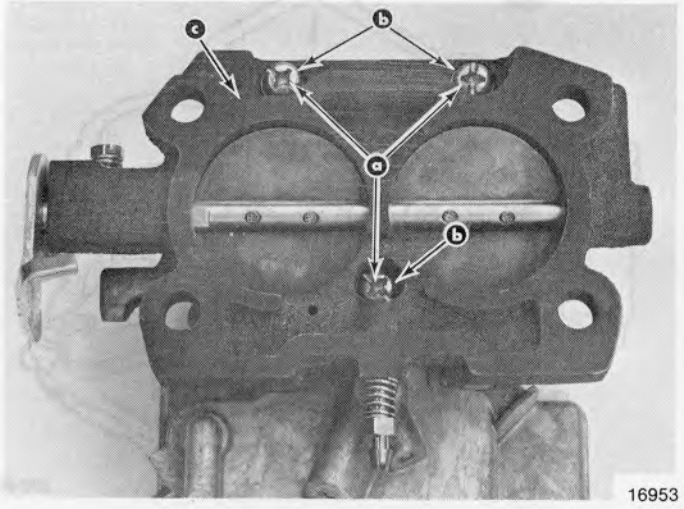


a - Idle Speed Screw
b - Spring

3. Install throttle body gasket.

a - Throttle Body Gasket
b - Locating Dowel

4. Install throttle body assembly on float bowl assembly. Tighten screws evenly and securely.

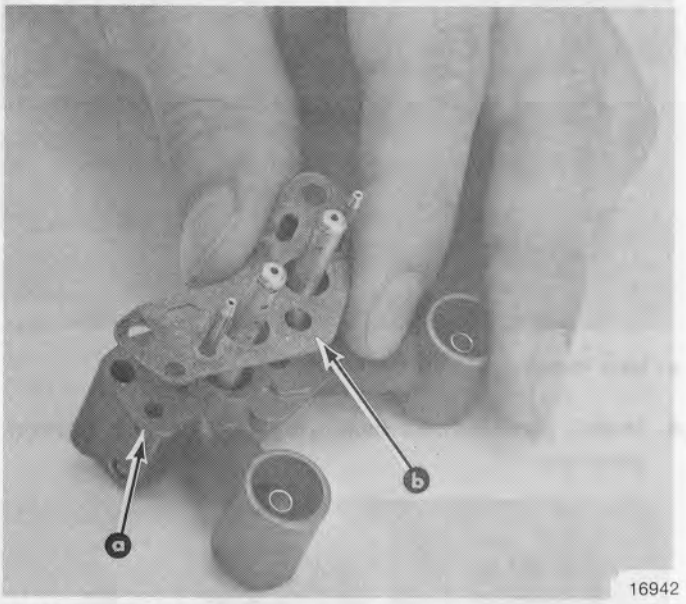


a - Screws
b - Lockwashers
c - Throttle Body Assembly

Float Bowl Assembly

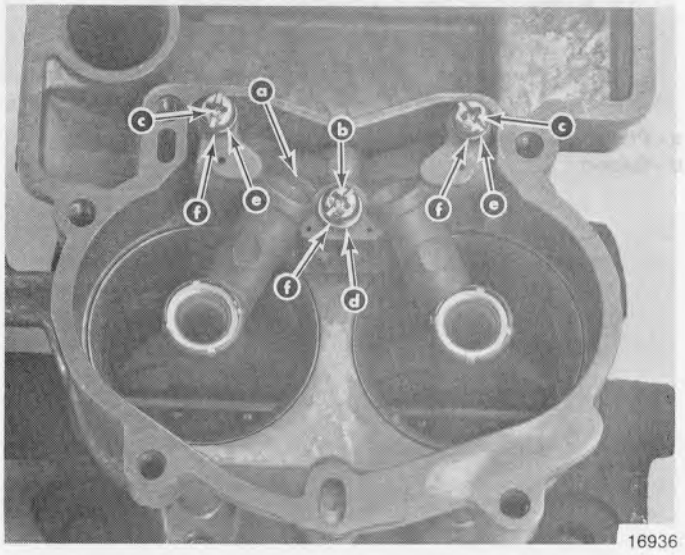
IMPORTANT: Place float bowl and throttle assemblies in a holding fixture to prevent throttle valves from being damaged.

1. Place new gasket over venturi cluster brass tubes.



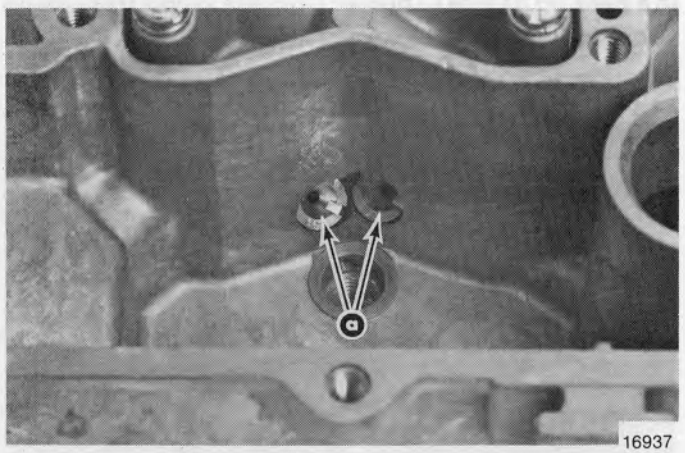
a - Venturi Cluster
b - Gasket

2. Install venturi cluster in float bowl, using three screws, metal gaskets and lockwashers. The center screw (with smooth shank) requires a fiber washer. The end screws use an aluminum gasket washer. Tighten all securely.



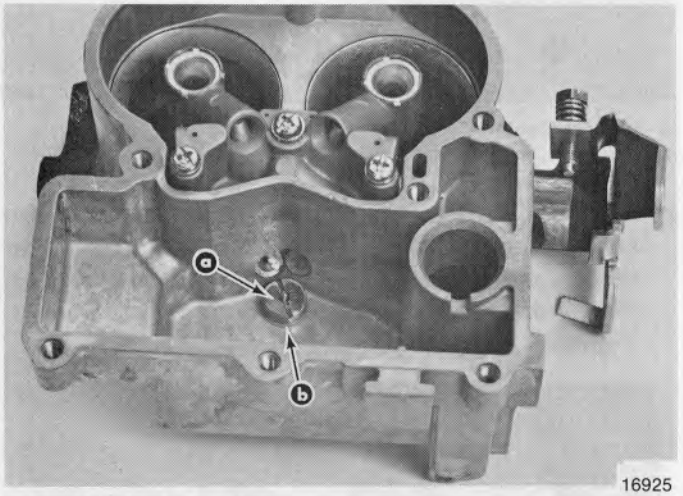
a - Venturi Cluster
b - Center Screw (with smooth shank)
c - Outer Screws
d - Fiber Washer
e - Lockwashers
f - Aluminum Gasket Washer

3. Install main metering jets and aluminum gaskets, tighten securely.



a - Main Metering Jets and Gaskets

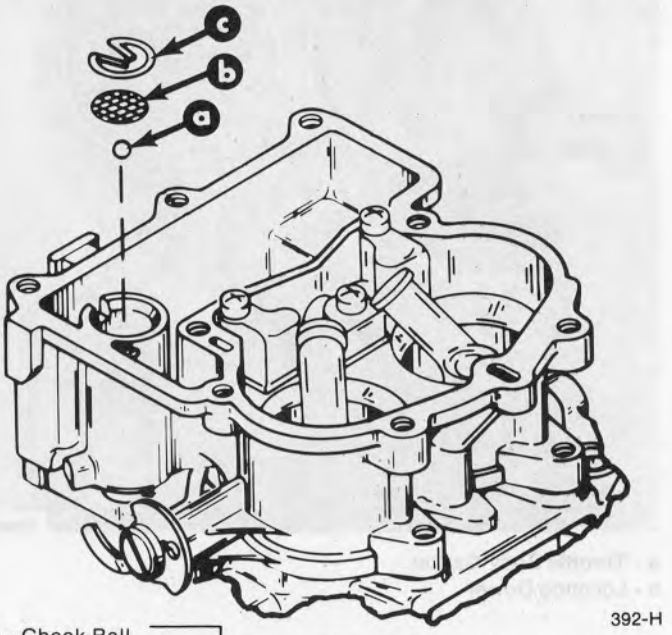
4. Install power valve assembly and gasket, tighten securely.



a - Power Valve Assembly
b - Gasket

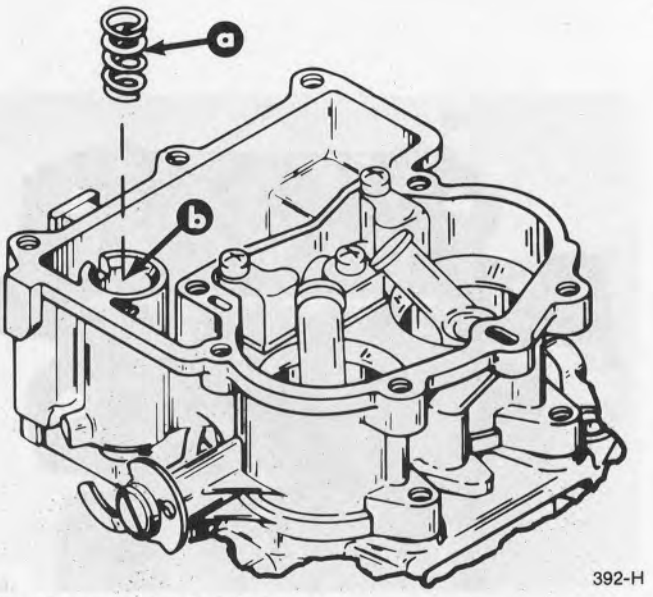
5. Place check ball in pump well; then, install strainer and retainer clip. (2cc pump only)

IMPORTANT: DO NOT use needle nose plier to install retainer, damage could occur to strainer. Strainer must be flat, dent's could cause interference with check ball.



a - Check Ball
b - Strainer
c - Retainer Clip
(2cc Pump Only)

6. Place accelerator pump return spring in pump well.

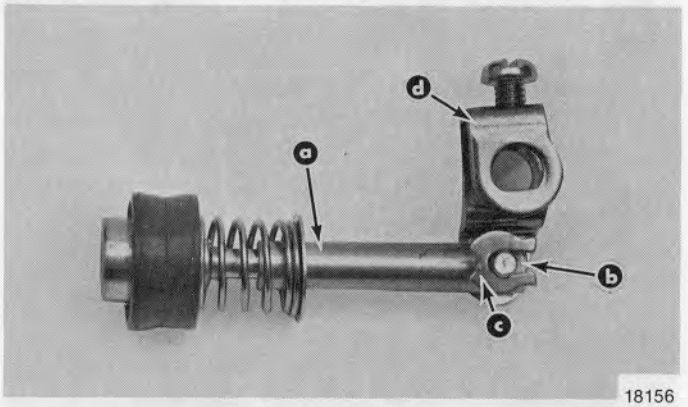


a - Accelerator Pump Return Spring
b - Pump Well

Air Horn Assembly

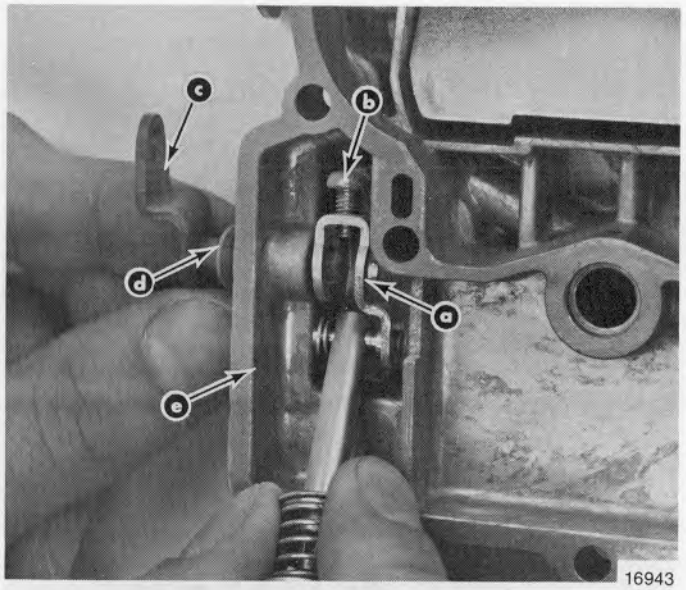
IMPORTANT: If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

1. Secure pump assembly to pump lever with washer and retainer clip, as shown.



a - Accelerator Pump Assembly (2cc Pump Shown)
b - Washer
c - Retainer Clip
d - Pump Lever

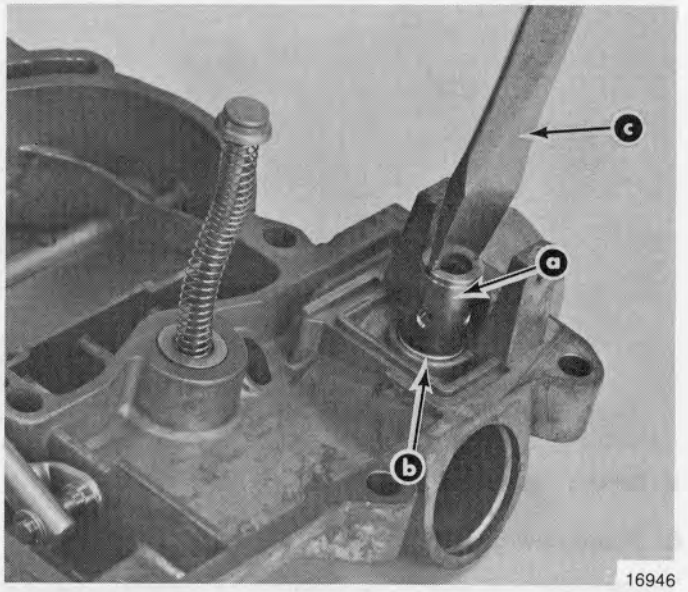
2. Insert pump shaft and lever assembly (and washer) into air horn; align indexed hole in pump lever with shaft and lever assembly and slide shaft all-the-way into lever so that shoulder on shaft is hitting lever. Tighten set screw securely.



a - Pump Lever
b - Set Screw
c - Pump Shaft and Lever Assembly
d - Washer
e - Air Horn

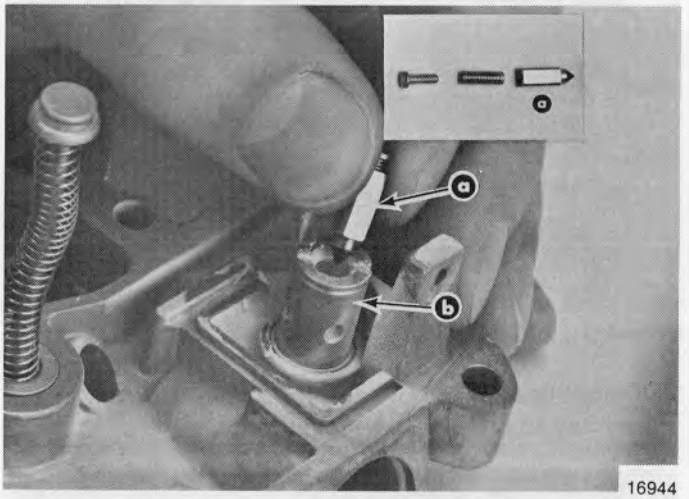
IMPORTANT: Needle and seat should be replaced only as a set.

3. Install needle seat and gasket.



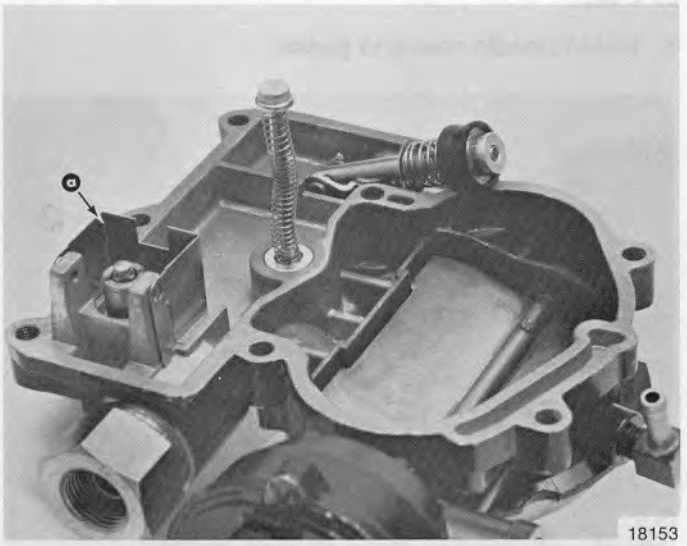
a - Needle Seat
b - Gasket
c - Screwdriver

4. Place needle assembly into needle seat.



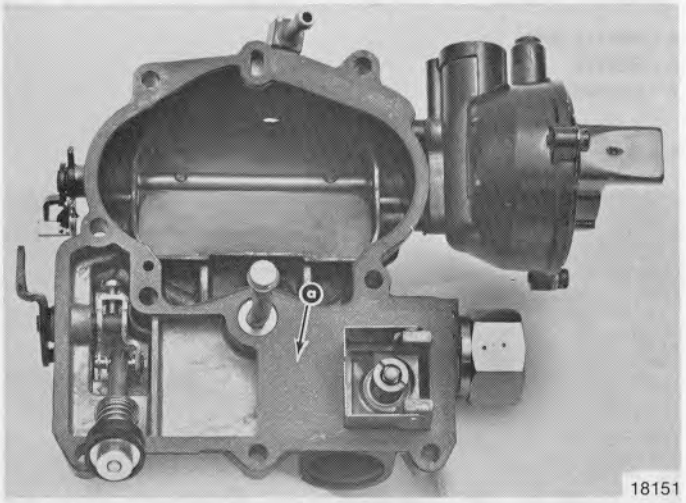
a - Needle Assembly
b - Needle Seat

5. Install baffle.



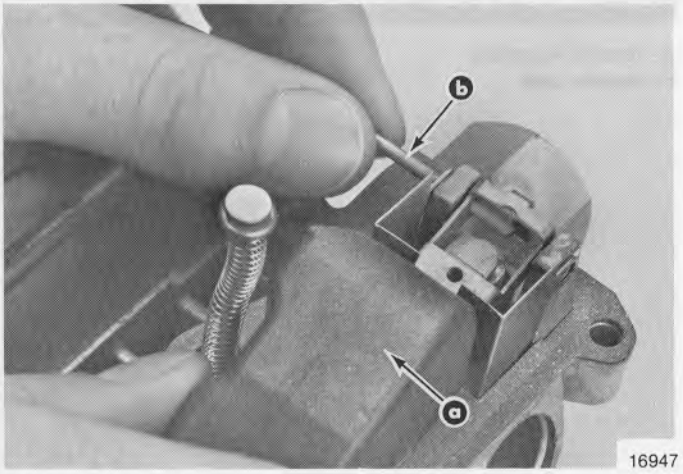
a - Baffle

6. Place new gasket on air horn.



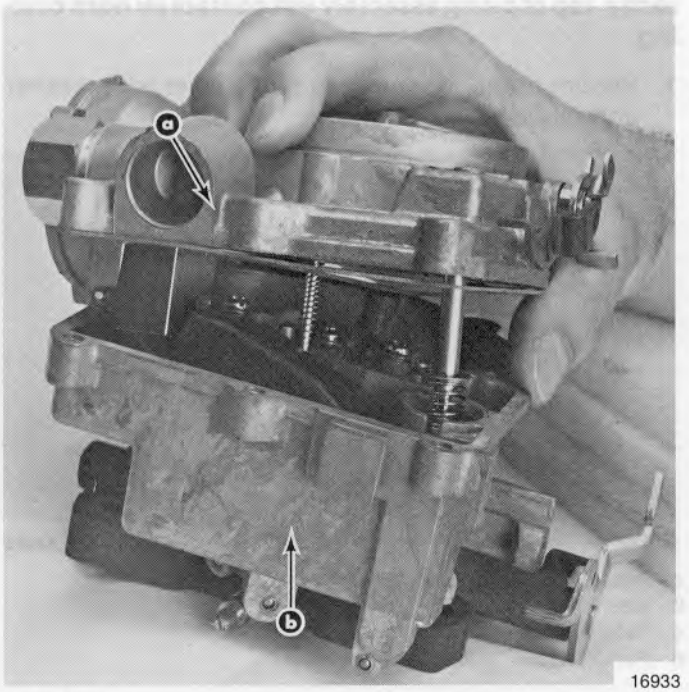
a - Gasket

7. Install float assembly and hinge pin. Pivot float assembly to ensure free movement.



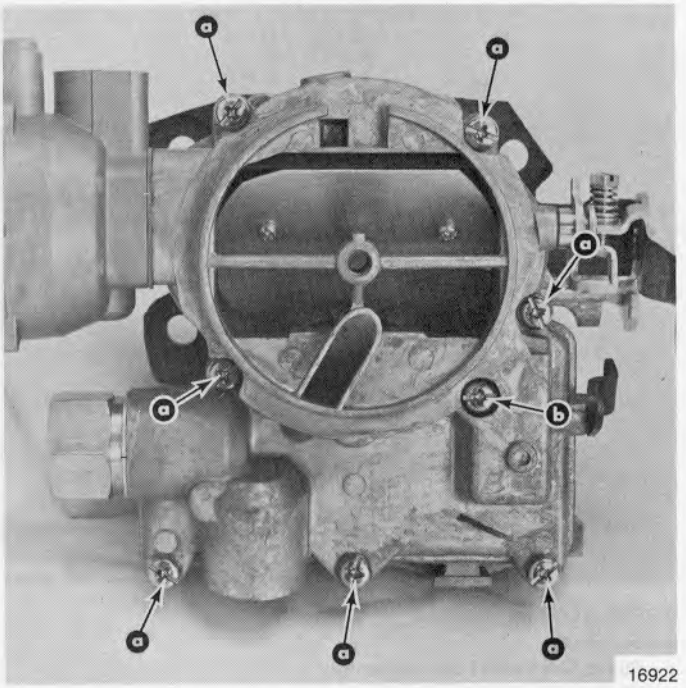
a - Float Assembly
b - Float Hinge Pin

8. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well.



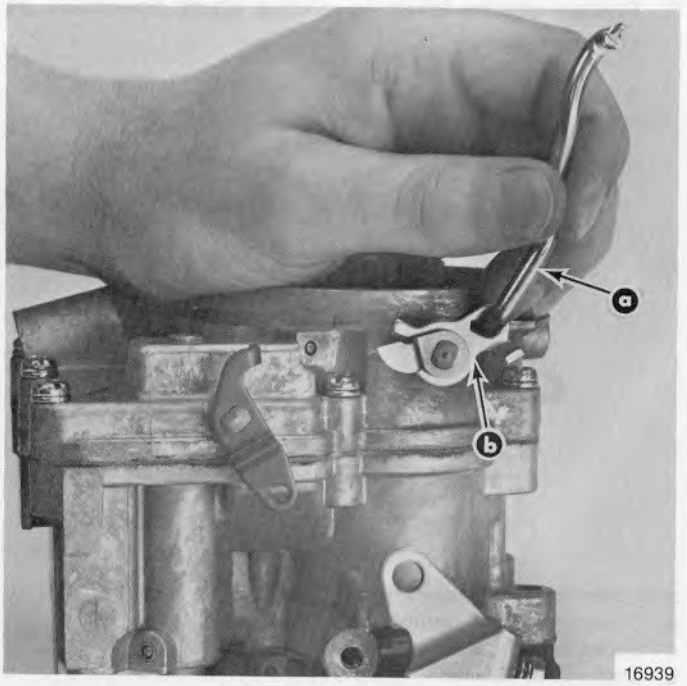
a - Air Horn
b - Float Bowl Assembly

9. Install air horn attaching screws and washers. Tighten evenly and securely.



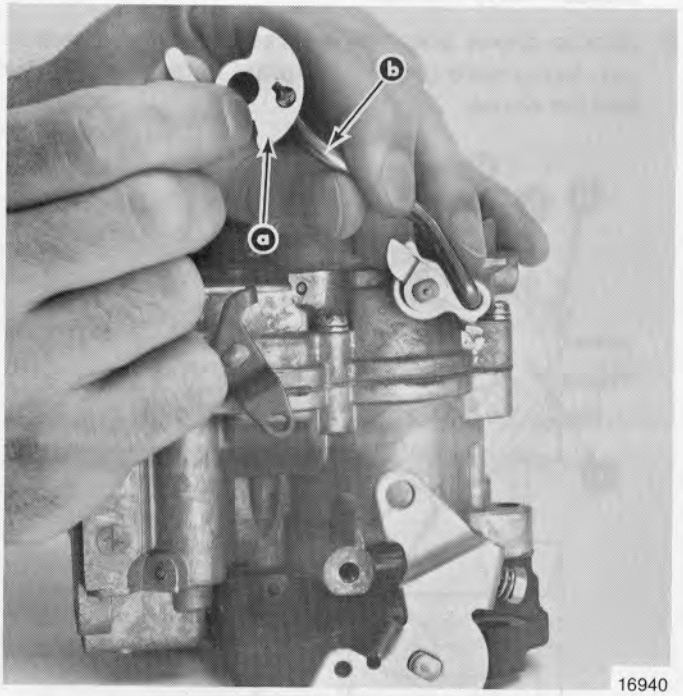
a - Seven Short Screws
b - One Long Screw

10. Place end of choke rod in choke lever and collar assembly.



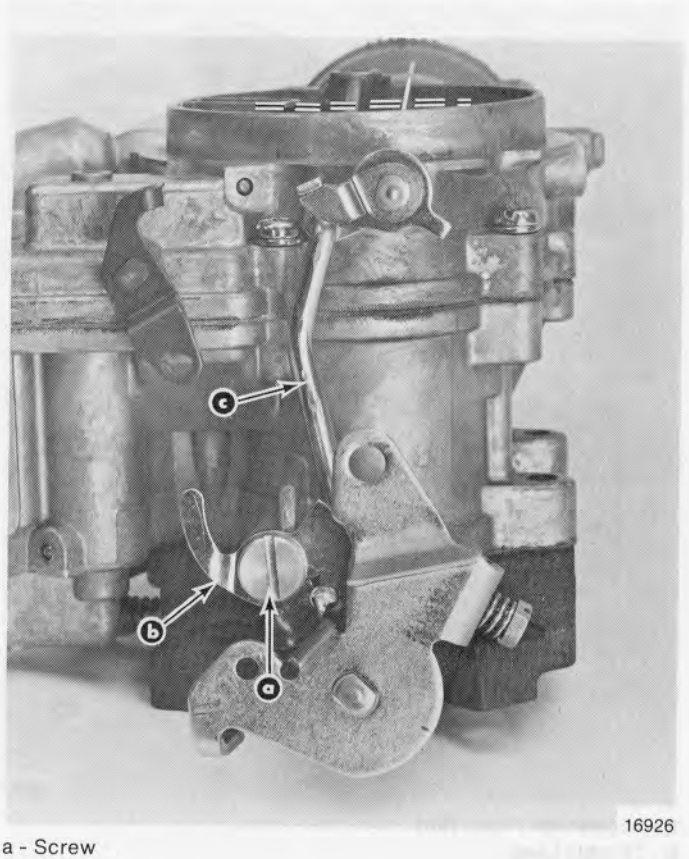
a - Choke Rod
b - Choke Lever and Collar Assembly

11. Place idle cam on choke rod as shown.



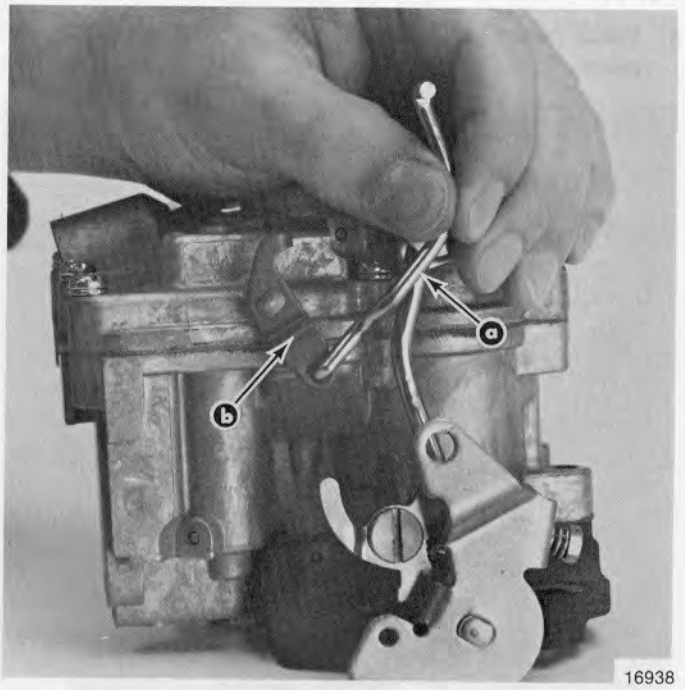
a - Idle Cam
b - Choke Rod

12. Secure idle cam (with choke rod installed on cam) as shown on float bowl assembly, with screw. Check that cam is free to move without binding.



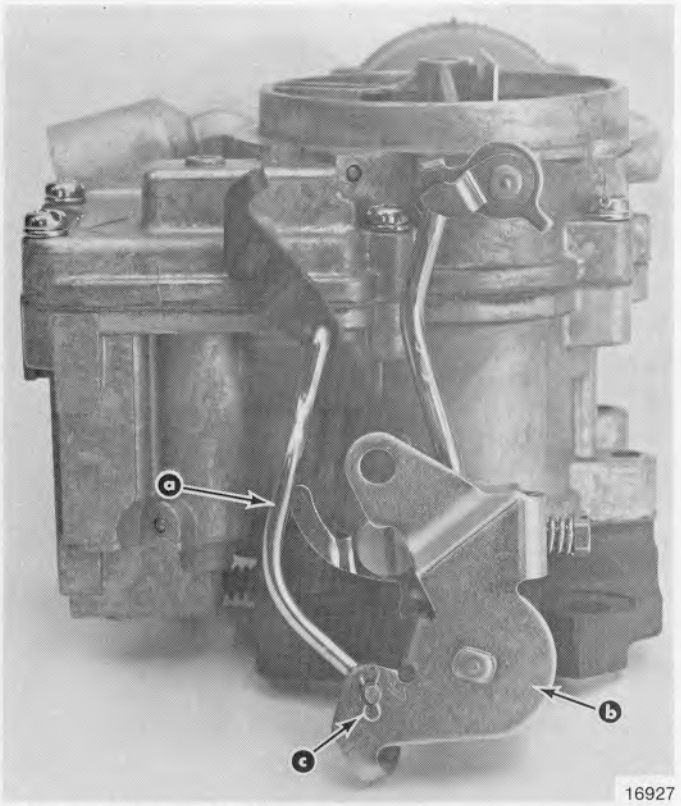
a - Screw
b - Idle Cam
c - Choke Rod

13. Place accelerator pump rod (end with ear) in hole in pump shaft and lever assembly as shown.



a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

14. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip as shown.

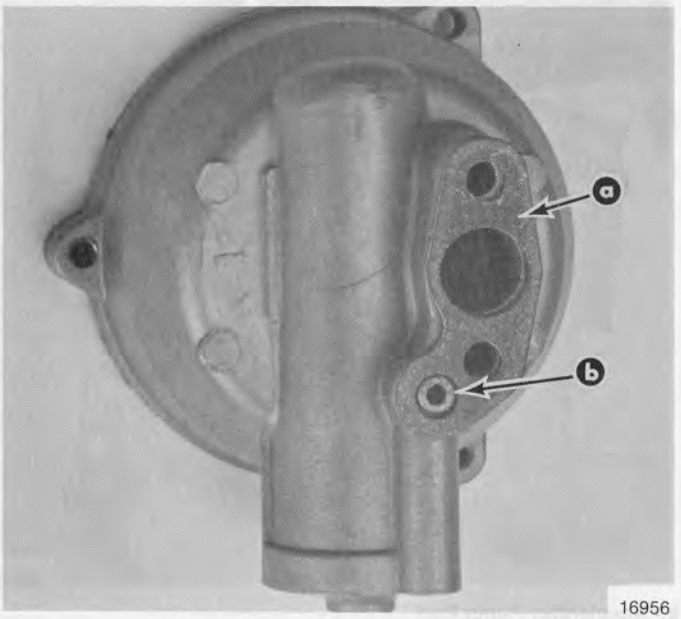


a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

Choke Housing Assembly

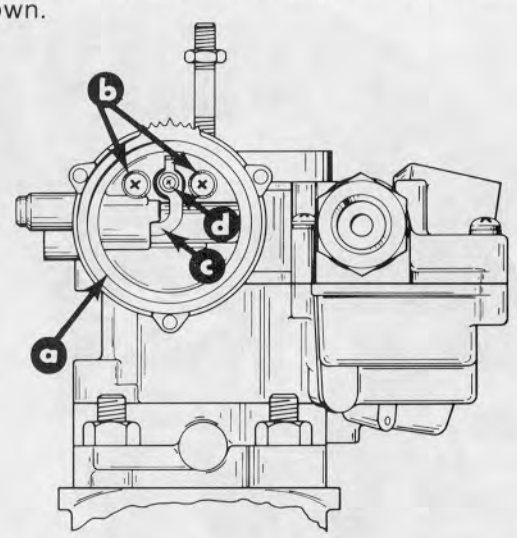
IMPORTANT: Not all MerCarb carburetors are equipped with choke housing gaskets.

1. Place new choke housing gasket in position on air horn.



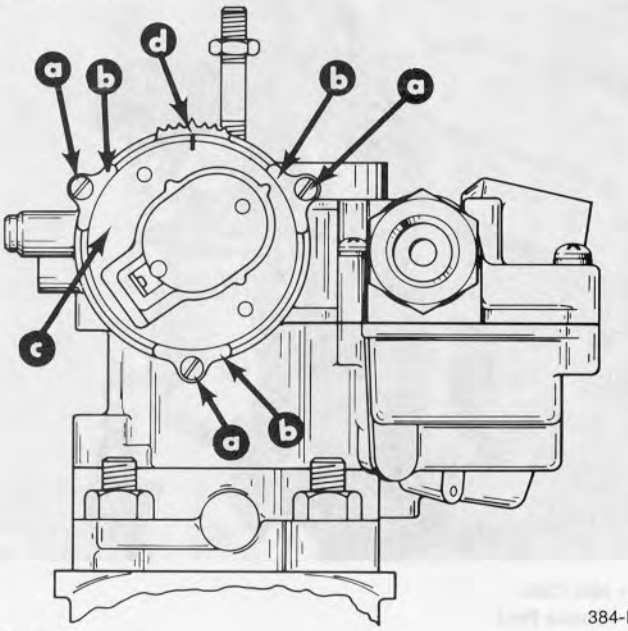
a - Gasket (Some Models)
b - Gasket Locating Pin

2. Secure choke housing assembly to air horn. Tighten securely.
3. Fasten choke lever to choke shaft assembly as shown.



a - Choke Housing Assembly
b - Choke Housing Assembly Attaching Screws
c - Choke Lever
d - Choke Lever Screw

4. Place choke cover on choke housing. Be sure hook on end of heating coil engages with choke lever. Rotate choke cover until alignment marks (made at disassembly) line up.
5. Secure choke cover with three screws and retainers, being sure ground terminal is fastened under bottom screw.



a - Screws
b - Retainer
c - Choke Cover
d - Alignment Marks

INSTALLATION

1. Clean gasket surfaces.
2. Place NEW carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque nuts evenly to specifications.

NOTE: If carburetor was disassembled install filter, spring, washers, and filter nut.

3. Connect fuel line to fuel inlet nut and torque to specifications.
4. Connect fuel pump vent hose to fitting on carburetor.
5. Connect electric choke connections to choke cover.
6. Install flame arrestor and crankcase ventilation hose.
7. Reconnect battery cables to battery.
8. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
9. Disconnect throttle cable.
10. Reset idle speed screw (RPM) so engine idles at 550-600 RPM in gear.
11. Adjust idle mixture screw.
12. Reset idle speed screw until engine idles at 650-700 RPM in forward gear.
13. Adjust and connect throttle cable.

Specifications

Rochester 4MC

CARBURETOR SPECIFICATIONS (with Wedge)

All Measurements are ± 1/64" (.4mm)

Make (Model)	Rochester (4MC)
Part No. Mercury (Rochester)	1347-8460 (17081299)
Float Level	(NOTE 1)
Float Weight (Max.)	9.88 grams
Pump Rod Hole Location	Inner
Accelerator Pump (NOTE 2)	23/64" (9.1mm)
Air Valve Dash Pot (Air Valve Rod)	.025" (.64mm)
Vacuum Break	.190" [3/16" (4.8mm)]
Air Valve Spring Wind Up	1/4 Turn (40-50 g)
Choke Adjustment	(NOTE 3)
Main Jet	.066"
Metering Rod (Primary)	.036"
Metering Rod (Secondary)	CZ-DE
Idle Mixture Screw Preliminary Setting	2-3 Turns

NOTES:

1) If Fuel Inlet Needle Is SPRING LOADED: Float Lever Must Just Touch Needle Ball. DO NOT Push Down On Ball. Float Level Is 1/4" (6.4mm). IF Fuel Inlet Needle Is SOLID TYPE: Float Level Is 3/8" (9mm).
2) Accelerator Pump Measurement Taken From Flame Arrestor Mounting Surface to Pump Stem with Throttle Plates Fully Closed.
3) Index Mark On Cover Should Be 1/4" To The Right Of The Leanest Index Mark On Choke Housing.

CARBURETOR SPECIFICATIONS (without Wedge)

All Measurements are ± 1/64" (.4mm)

Make (Model)	Rochester (4MC)
Part No. Mercury (Rochester)	1347-9142A2 (17083522)
Float Level	3/8" (9mm)
Float Weight (Max.)	9.88 grams
Pump Rod Hole Location	Inner
Accelerator Pump (NOTE 1)	23/64" (9.1mm)
Air Valve Dash Pot (Air Valve Rod)	.025" (.64mm)
Vacuum Break	.190" [3/16" (4.8mm)]
Air Valve Spring Wind Up	1/4 Turn (40-50 g)
Choke Adjustment	(NOTE 2)
Main Jet	.066"
Metering Rod (Primary)	.036"
Metering Rod (Secondary)	CZ-DE
Idle Mixture Screw Preliminary Setting	2-3 Turns

NOTES:

1) Accelerator Pump Measurement Taken From Flame Arrestor Mounting Surface to Pump Stem With Throttle Plates Fully Closed.
2) Index Mark On Cover Should Be 1/4" To The Right Of The Leanest Index Mark On Choke Housing.

Torque Specifications

FASTENER LOCATION	LBS. FT. (N.m)
Nut - Carburetor to Manifold	20 (27)
Fitting - Fuel Line to Carburetor	18 (24)
Nut - Fuel Inlet Filter	18 (24)

Special Tools

MERCURY MARINE SPECIAL TOOLS	
91-36392	Universal Carburetor Gauge

BORROUGHS TOOL & EQUIPMENT CORP. 2429 N. BURDICK ST. KALAMAZOO, MI 49007 TEL: 616-345-5163	
BT-8128B	Float Scale
BT-8420A	Float Level Gauge

KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J9789-118	Carburetor Stand
J22769	Needle Valve Seat Remover

WAGNER INSTRUMENTS P.O. BOX 1217 GREENWICH, CT 06836 TEL: 203-869-9681	
Model G.D. 150	Gram Scale

Description

The 4MV and 4MC Quadrajets are 4 barrel, 2 stage carburetors. Both the 4MV and 4MC are of the same design, the only real difference being in the choke operation. The 4MV has a manifold mounted choke thermostat housing, and a link rod attaching the thermostat spring to the carburetor choke linkage. The 4 MC has the choke thermostat housing mounted directly on the airhorn of the carburetor. The thermostat spring is hooked directly to the carburetor choke linkage.

The Quadrajet carburetor has 2 stages in operation. The primary (fuel inlet) side has small bores with a triple venturi set-up equipped with plain tube nozzles. Its metering principles are similar to most plain tube carburetors which use the venturi principle. The triple venturi stack up, plus smaller primary bores, give a more stable and finer fuel control in idle and economy ranges of operation. Fuel metering in primary side is accomplished with tapered metering rods positioned by a manifold vacuum responsive piston.

The secondary side has 2 very large bores which have greatly increased air capacity to meet present day and future engine demands. The air valve principle is used in the secondary side for metering control and supplements fuel flow from the primary bores.

Using the air valve principle, fuel is metered in direct proportion to air passing thru the secondary bores.

The fuel reservoir is centrally located to avoid problems of fuel slosh causing engine turn cut-out and delayed fuel to carburetor bores. The float system uses a single float pontoon for ease in servicing the unit.

Precautions

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

Diagnosis - 4 Barrel

The fuel system must maintain a fuel pressure of 3 to 7 lbs. to function properly. Before repairing or disassembly of the carburetor check the following:

1. Sufficient amount of fuel in tank.
2. Tank correctly vented.
3. Check anti-siphon valve.
4. All filters in system are clean.
5. Proper fuel line routing (not kinked or pinched).
6. All fittings secure with no air or fuel leaks.
7. Operate throttle lever and observe that fuel is being injected into throttle bore.
8. Check choke to ensure full closure.
9. Check all air horn retaining screws for tightness.
10. Check carburetor retaining studs and bolts.

If problems continue refer to troubleshooting section.

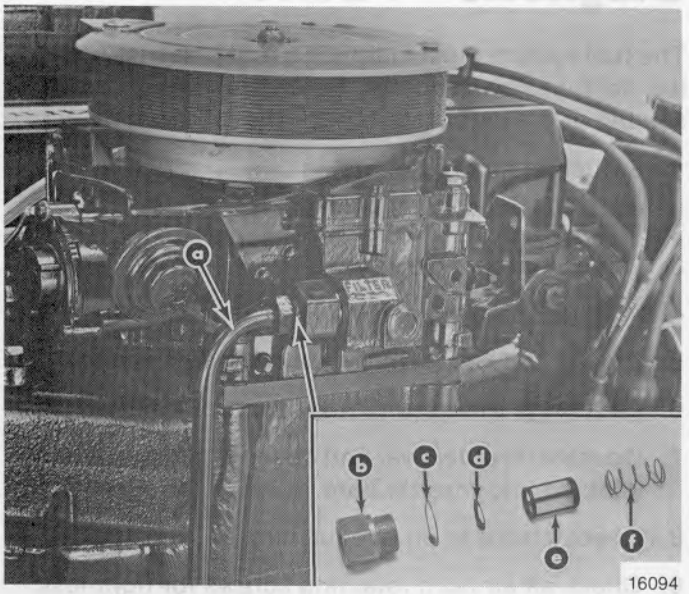
Maintenance

CHANGING FUEL FILTER

⚠WARNING

Be careful when changing fuel filter; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

1. Remove:
   a. Fuel line from fuel inlet filter nut
   b. Fuel inlet filter nut
   c. Large gasket
   d. Filter
   e. Spring
   f. Small gasket - From inside filter nut



a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

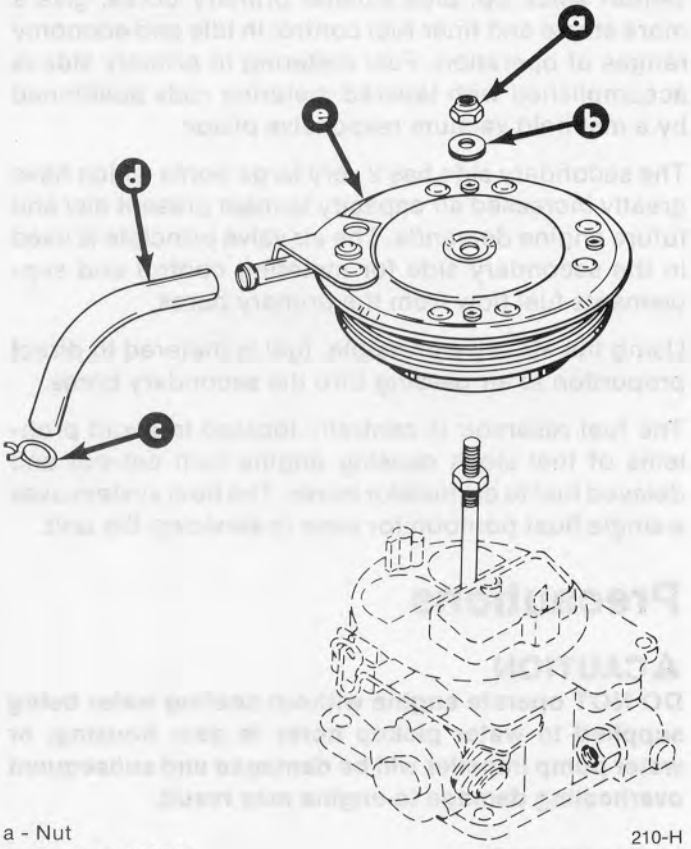
2. Clean filter nut and spring.
3. Install the following:
   a. Spring - Place in carburetor body
   b. Filter - Open end to inlet filter nut
   c. Small gasket - Place inside filter nut
   d. Large gasket - Place over filter nut
   e. Fuel inlet filter nut - Tighten to specifications
   f. Fuel line - Tighten to specifications

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

CLEANING FLAME ARRESTOR and CRANKCASE VENTILATION HOSES

⚠CAUTION
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

1. Remove:
   a. Nut
   b. Sealing washer
   c. Hose clamps and crankcase ventilation hose
   d. Flame arrestor



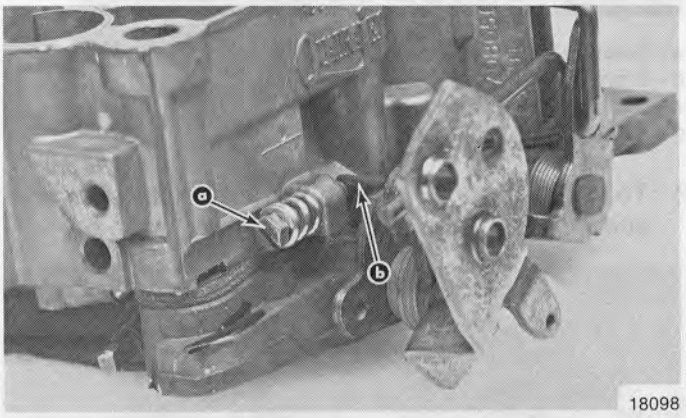
a - Nut
b - Sealing Washer
c - Hose Clamp
d - Crankcase Ventilation Hose
e - Flame Arrestor

2. Clean and inspect:
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hose.
   c. Inspect crankcase ventilation hose for cracks or deterioration, and replace if necessary.
3. Install in the following order:
   a. Flame Arrestor
   b. Crankcase ventilation hose and hose clamp - to flame arrestor and rocker arm cover.
   c. Sealing washer
   d. Nut - Tighten securely

Adjustments

ACCELERATOR PUMP

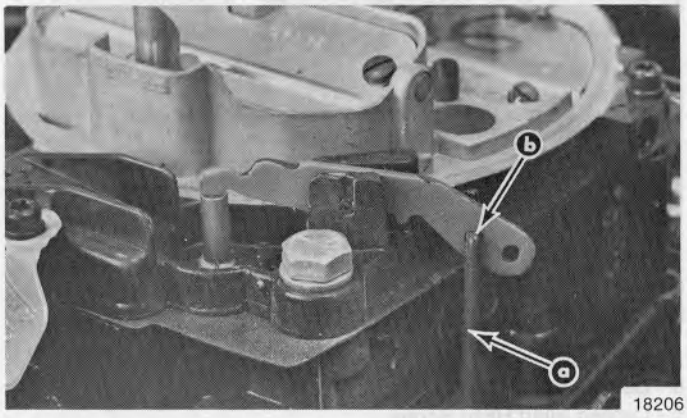
1. Back out idle stop screw until it no longer contacts throttle lever.



18098

a - Idle Stop Screw
b - Throttle Lever

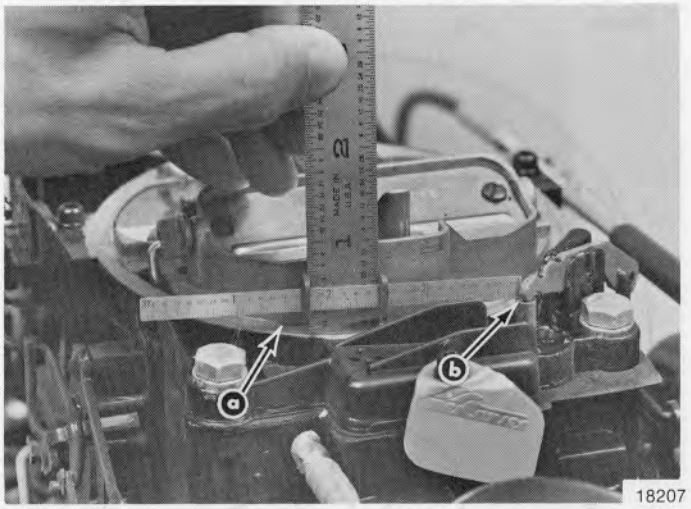
2. Pump rod must be in inner hole of lever.



18206

a - Pump Rod
b - Inner Hole

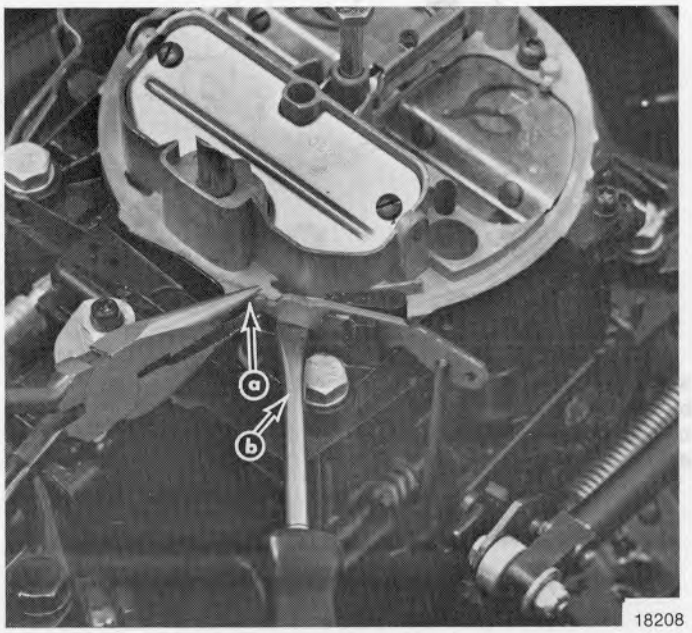
3. Close throttle valves completely and measure from flame arrestor mounting surface to top of pump plunger stem to specifications.



18207

a - Flame Arrestor Mounting Surface
b - Pump Plunger Stem

4. While supporting lever, bend tip of pump lever to obtain specified dimension.

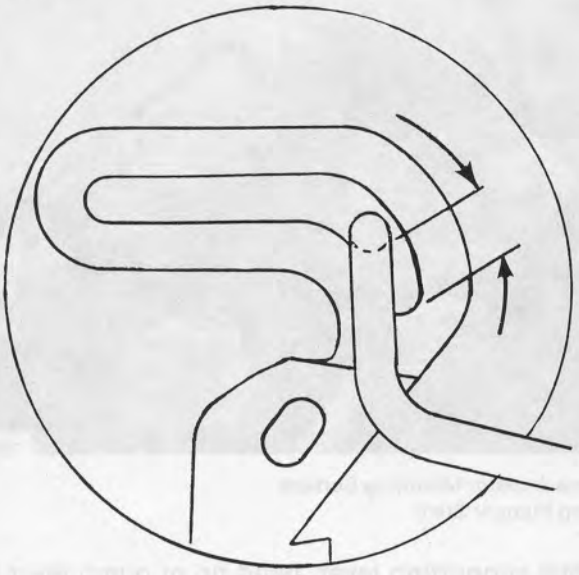


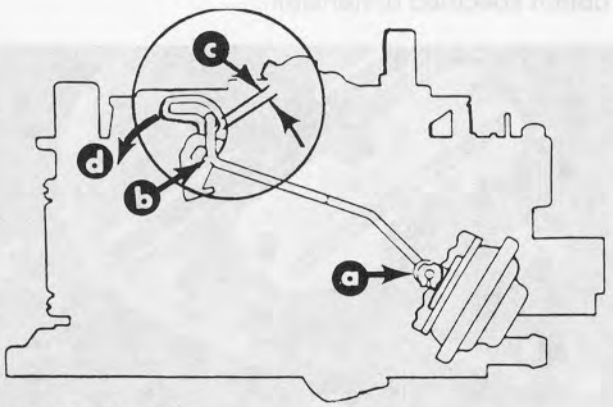
18208

a - Tip of Pump Lever
b - Support As Shown

AIR VALVE DASHPOT

1. Seat vacuum break diaphragm and close air valve completely. Bend rod to adjust gap to specifications.

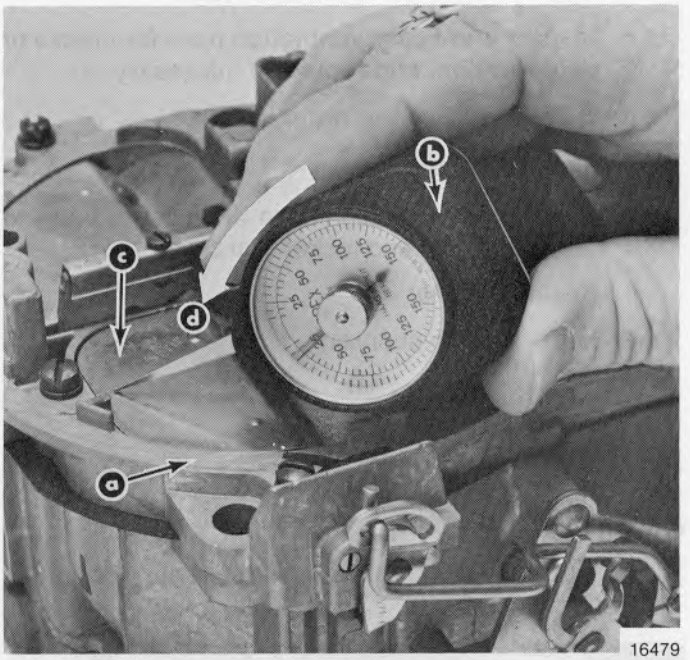




a - Push In Completely
b - Bend Here to Adjust
c - Gap per Specifications
d - Fully Closed

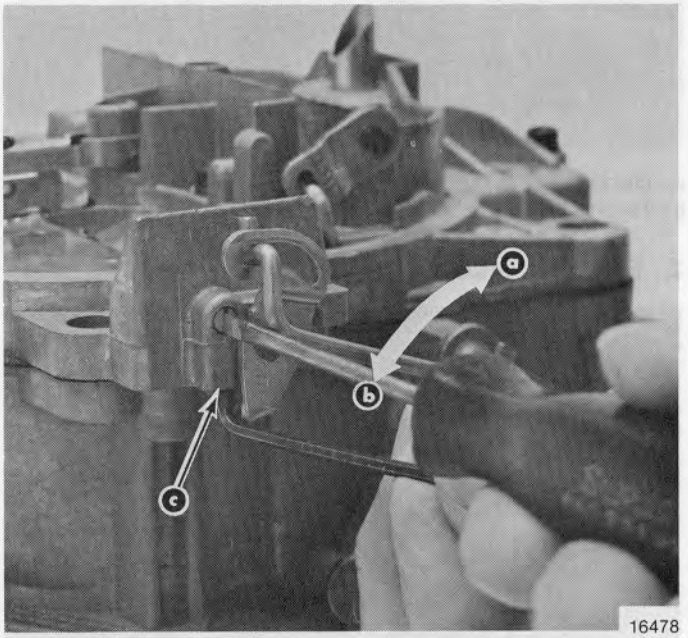
AIR VALVE SPRING WINDUP

1. Rotate gram scale (G.D. 150) until air valve begins to open, check scale reading to specifications.



a - Carburetor Casting
b - Gram Scale
c - Contact Area of Arm on Air Valve
d - Rotate

2. To adjust spring windup, hold tension spring screw and loosen allen head screw.

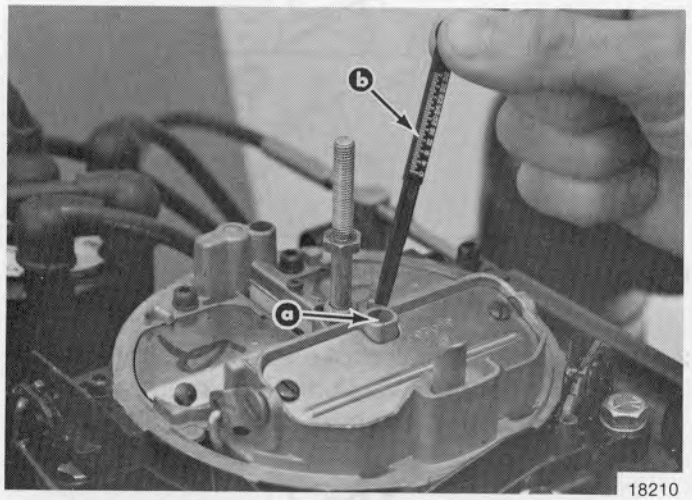


a - Increase
b - Decrease
c - Loosen Allen Head Screw

3. Adjust tension and retighten allen screw securely.

FLOAT LEVEL

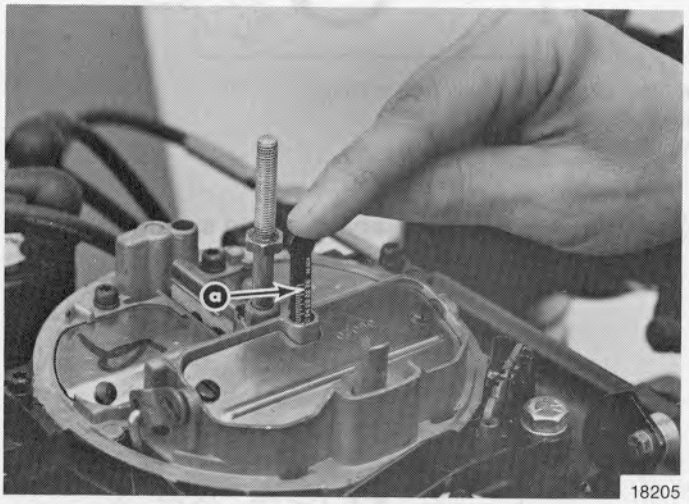
1. Start engine to fill float bowl, run at idle and insert float gauge into hole next to flame arrestor stud.



18210

a - Gauge Hole
b - Gauge (BT-8420A)

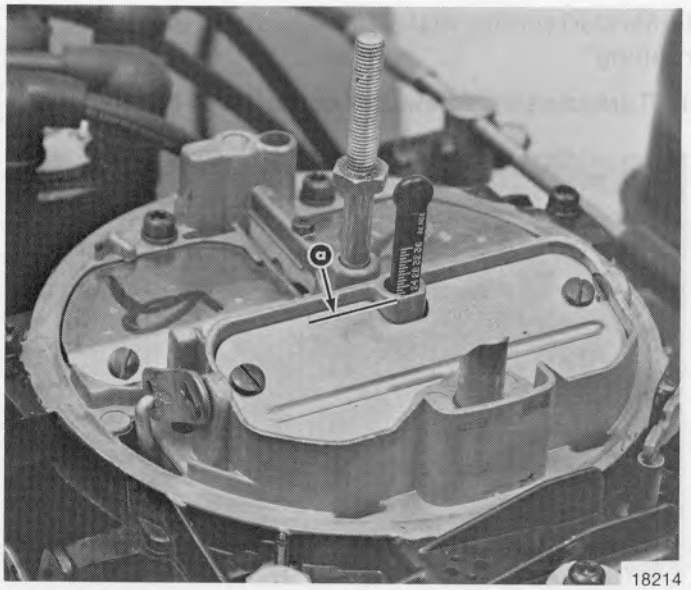
2. Tap float gauge down lightly to assure free movement.



18205

a - Gauge

3. Take gauge reading at top of carburetor casting.



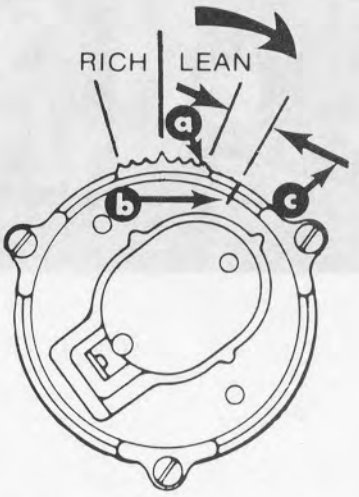
18214

a - Read Here

4. If float requires adjustment, refer to reassembly.

CHOKE ADJUSTMENT

1. Adjust choke 1/4" (6mm) past the last lean mark on choke housing.

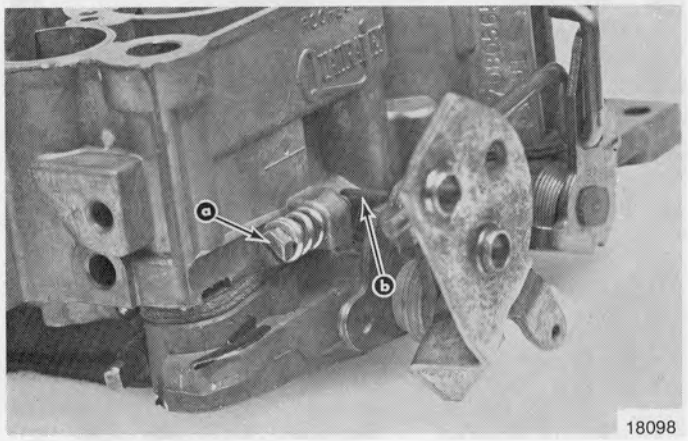


a - Last Index Mark on Choke Housing on Lean Side
b - Index Mark on Choke Cover
c - 1/4" (6mm)

IDLE SPEED and MIXTURE

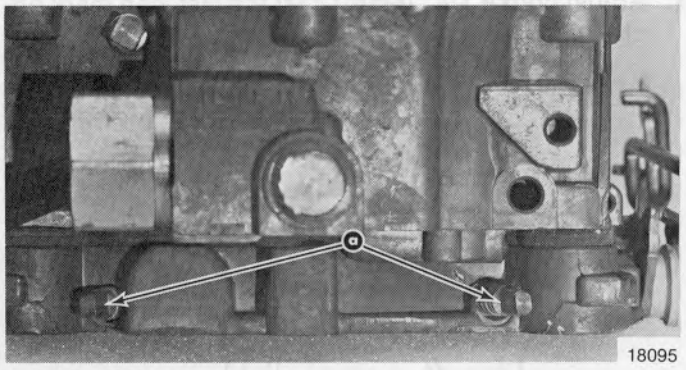
Initial start setting, make final adjustments with engine running.

1. Turn idle stop screw until contact with throttle lever.



a - Idle Stop Screw
b - Throttle Lever

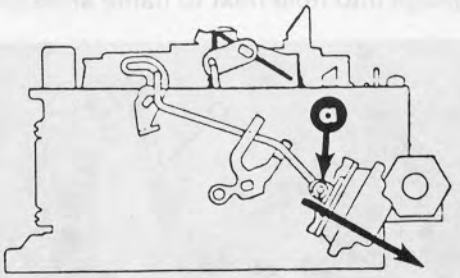
2. Turn idle needles in until lightly seated, then back out 2 to 3 turns equally.



a - Idle Needles

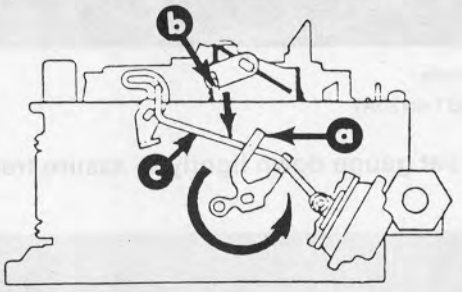
VACUUM BREAK

1. Seat vacuum break control diaphragm.



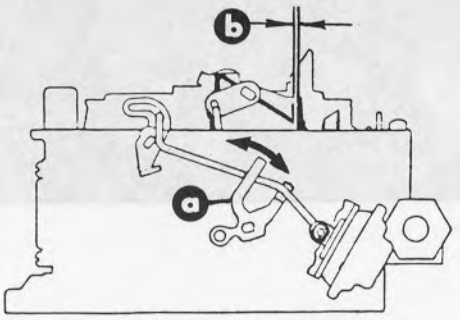
a - Vacuum Break Control Diaphragm

2. Rotate vacuum break choke lever counterclockwise until tang contacts vacuum break rod. Choke rod must be at bottom of choke shaft lever slot.



a - Vacuum Break Choke Lever Tang
b - Vacuum Break Rod
c - Choke Rod

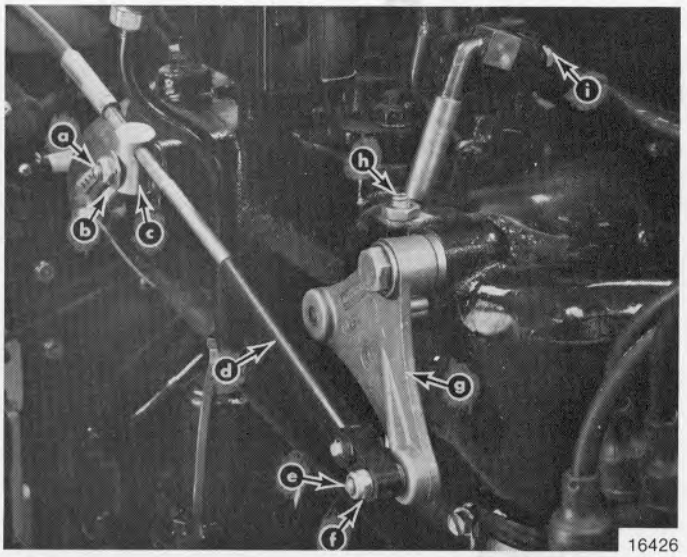
3. Bend tang as necessary to obtain specified choke valve gap.



a - Tang
b - Specified Gap

THROTTLE CABLE

1. Place remote control in neutral.
2. Lubricate anchor studs at carburetor.
3. Install cable end guide, flat washer and elastic stop nut onto anchor stud.
4. Grasp cable behind brass barrel and push lightly to align barrel to anchor stud.
5. Adjust barrel by turning in direction required to align with stud.



16426

a - Anchor Stud (with Spacer on Shank)
b - Flat Washer and Elastic Stop Nut
c - Throttle Cable Brass Barrel
d - Throttle Cable End Guide
e - Throttle Lever Stud
f - Flat Washer and Elastic Stop Nut
g - Bushing
h - Throttle Lever
i - Idle Speed Adjustment Screw

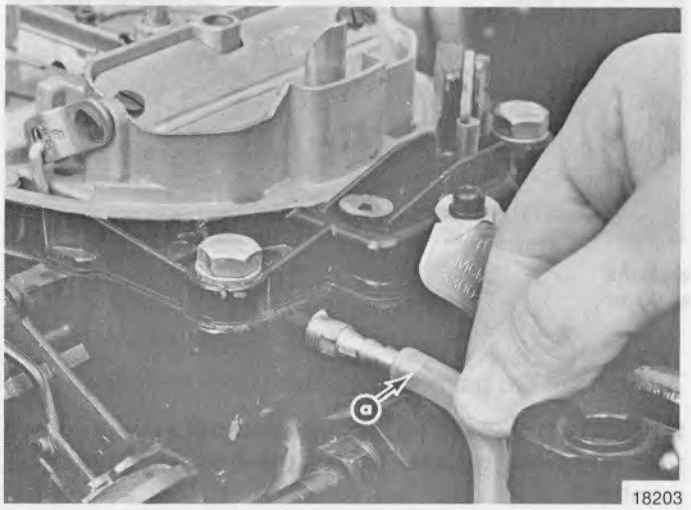
6. Secure brass barrel to stud with flat washer and elastic stop nut.
7. Shift to full throttle. Throttle plates must be completely open.
8. Shift to neutral. Throttle plates must be completely closed.

Carburetor Repair

REMOVAL

NOTICE
Refer to "Adjustments" for adjustments made during reassembly.

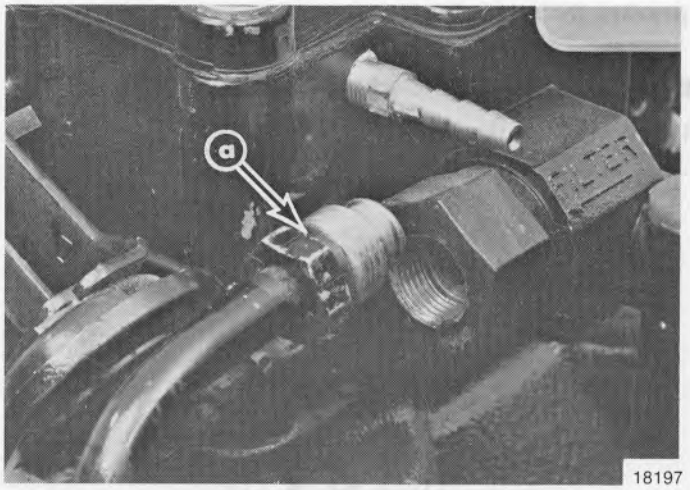
1. Remove flame arrestor.
2. Disconnect choke wiring.
3. Disconnect sight tube.



18203

a - Sight Tube

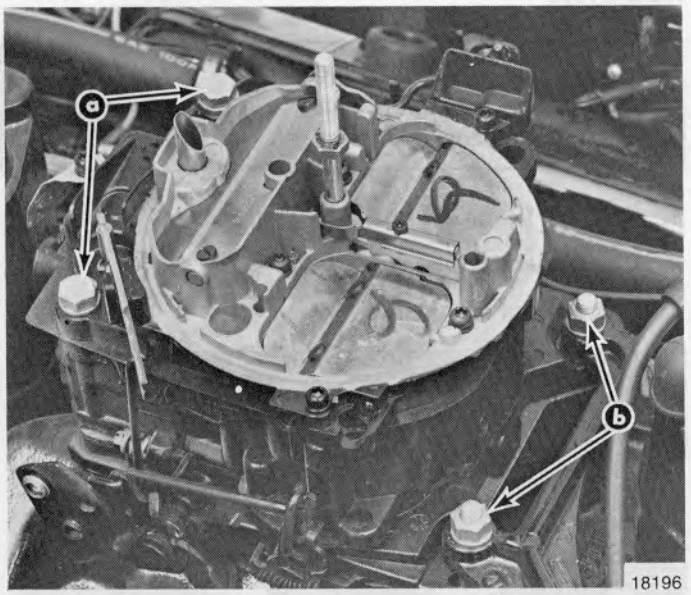
4. Disconnect fuel line.



18197

a - Fuel Line

5. Disconnect throttle cable.
6. Remove retaining nuts and bolts.



18196

a - Bolts
b - Nuts

7. Remove old gasket from carburetor and manifold.

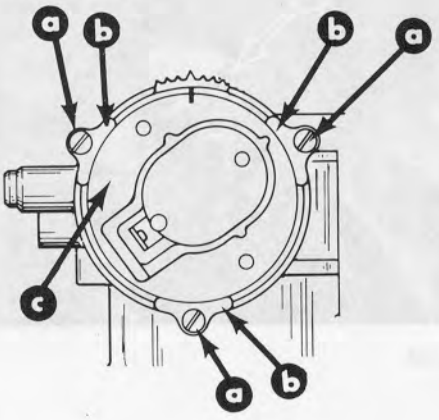
IMPORTANT: Place a cloth into manifold opening before removing gasket, to keep debris from entering manifold.

DISASSEMBLY

IMPORTANT: Place carburetor on a holding fixture to prevent throttle valve damage.

Electric Choke (4MC Carburetors Only)

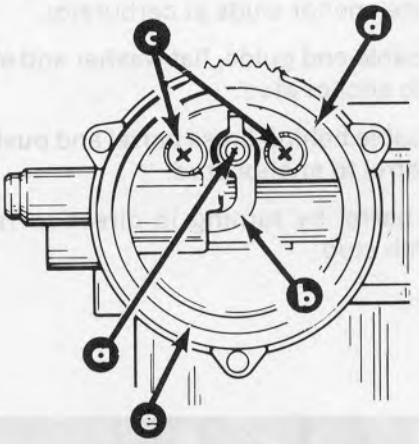
1. Remove choke cover.



384-H

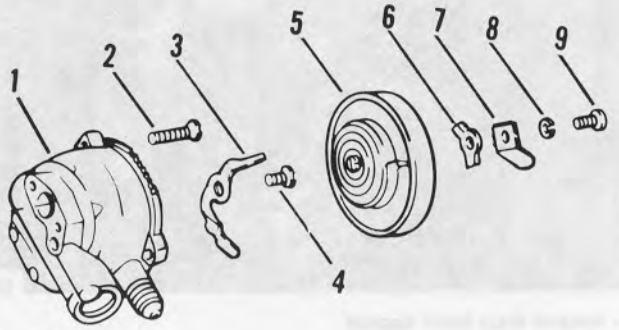
a - Screws
b - Retainers
c - Choke Cover

2. Remove choke lever screw.
3. Remove choke housing assembly.



384-H

a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly
d - Gasket - If Equipped (Not Visible)
e - Choke Housing Assembly



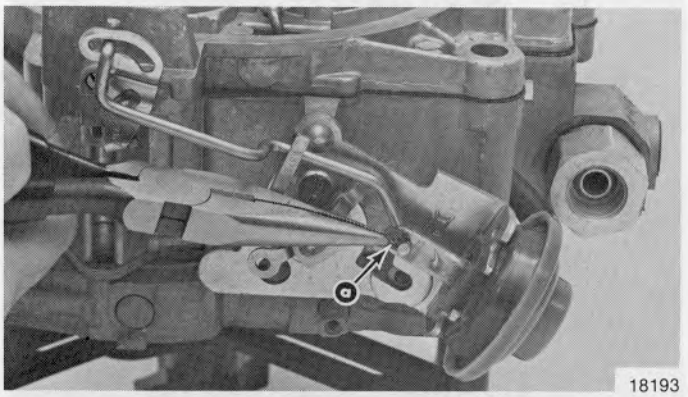
1 - Choke Housing
2 - Screw
3 - Lever
4 - Screw
5 - Choke Cover and Thermostat
6 - Retainer
7 - Terminal
8 - Lockwasher
9 - Screw

Exploded View of Electric Choke

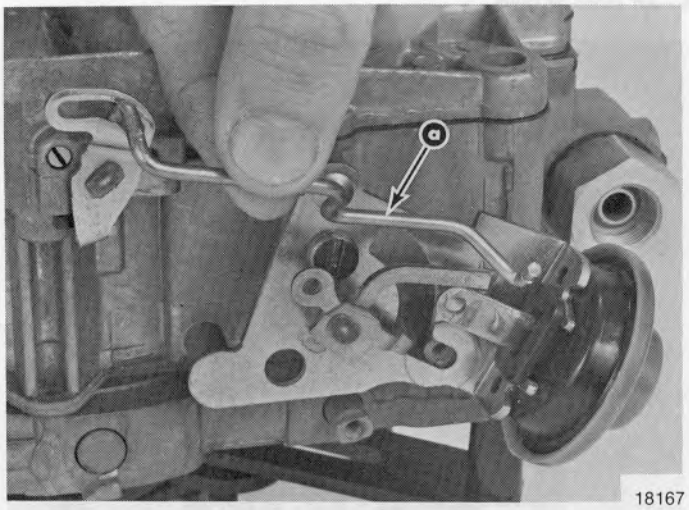
Air Horn

IMPORTANT: Place carburetor on a holding fixture to prevent throttle valve damage.

1. Remove vacuum pump rod clip and rod.

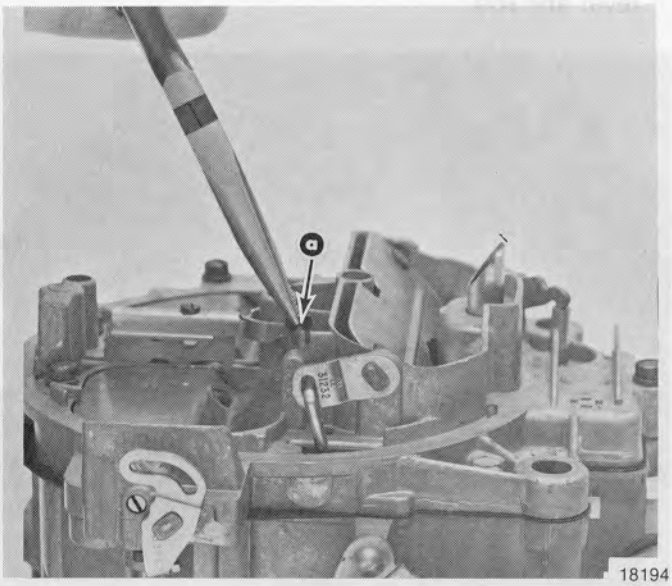


a - Rod Clip

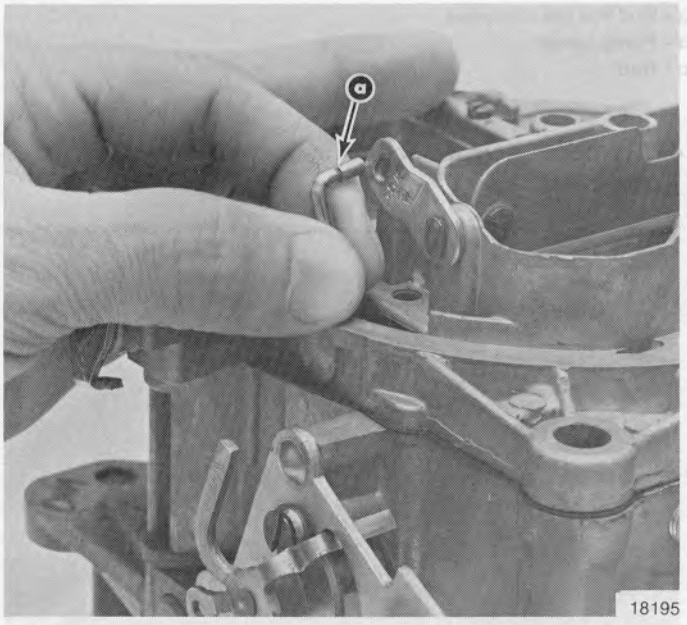


a - Rod

2. Remove choke shutter rod clip and rod.

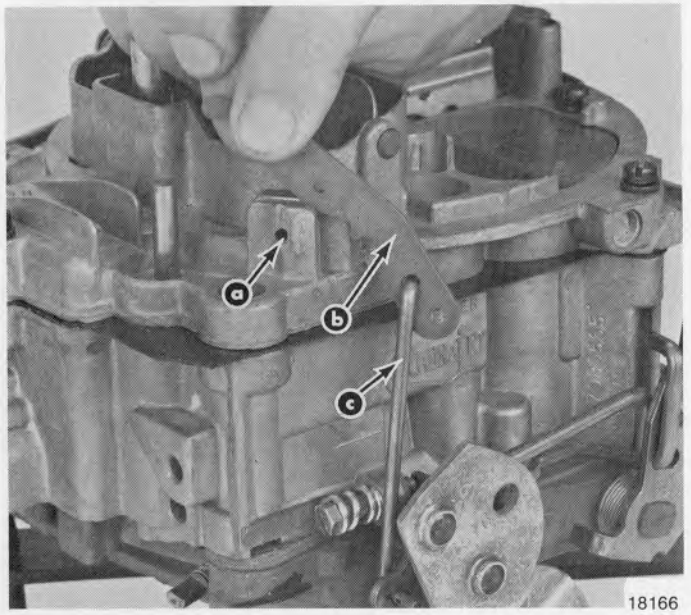


a - Clip



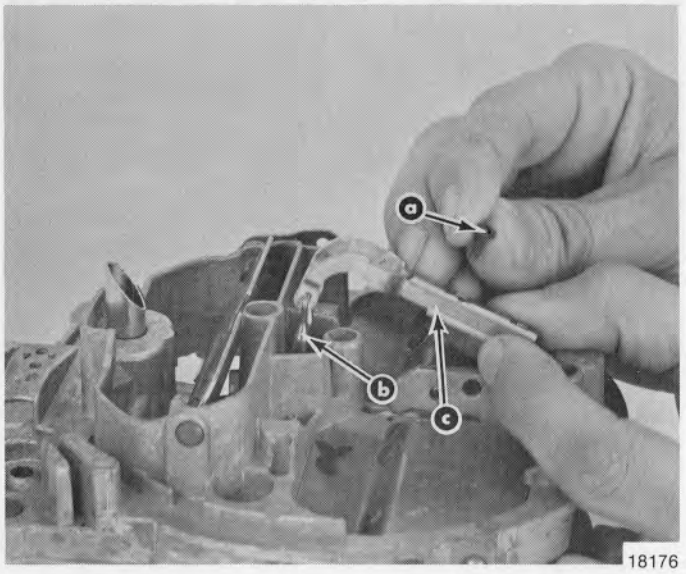
a - Rod

3. Drive roll pin back and remove accelerator pump lever and rod.



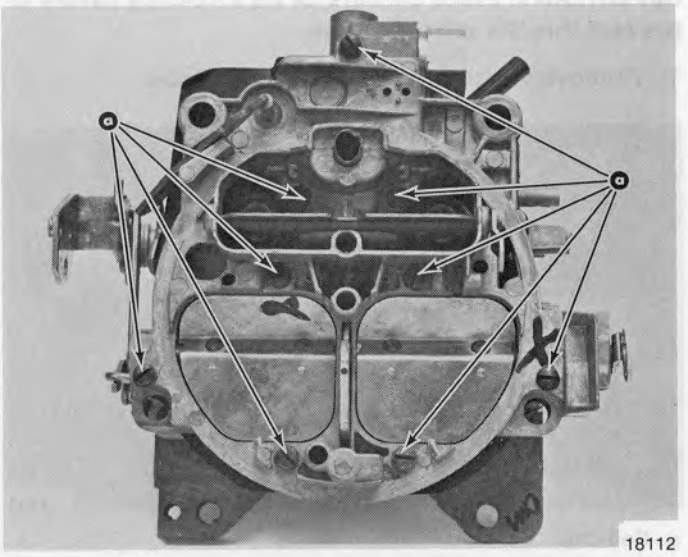
a - Roll Pin (Not Shown)
b - Pump Lever
c - Rod

4. Remove screw, secondary metering rods and bracket.

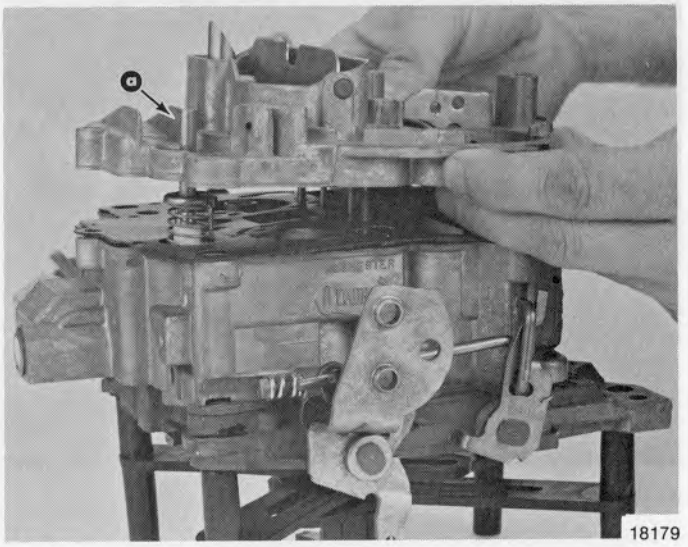


a - Screw
b - Metering Rods
c - Bracket

5. Remove air horn screws and air horn.



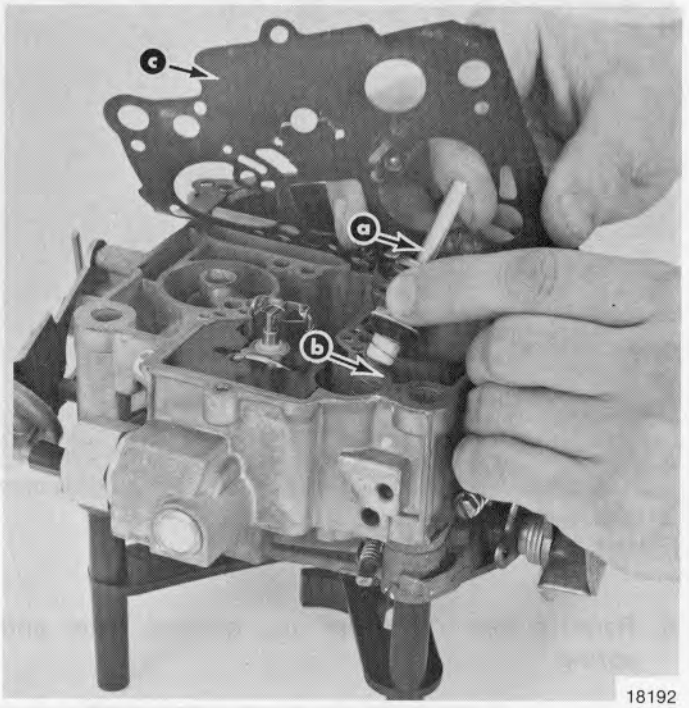
a - Air Horn Screws



a - Air Horn

Float Bowl

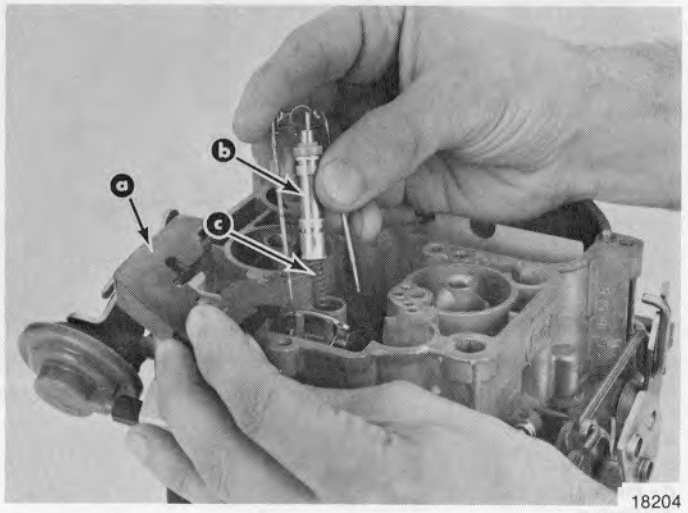
1. Remove pump plunger, return spring and gasket.



18192

a - Pump Plunger
b - Return Spring
c - Gasket

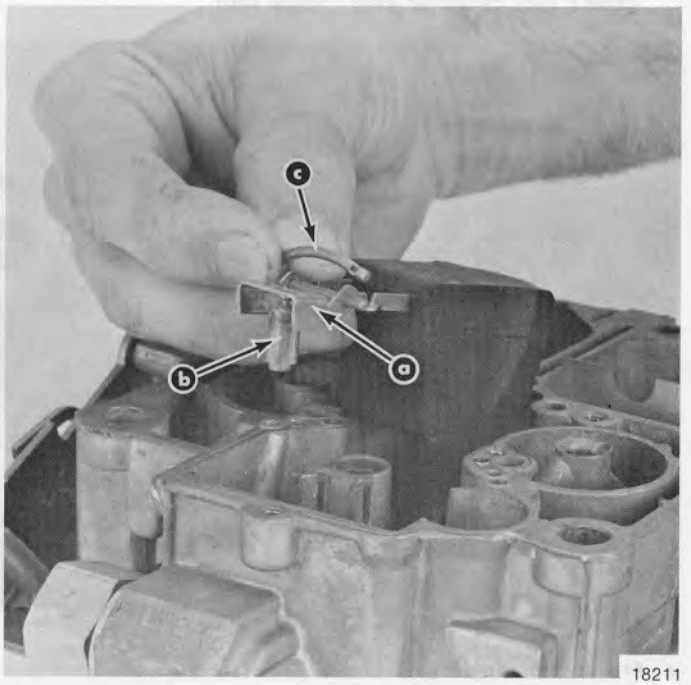
2. Remove insert block, power piston and spring.



18204

a - Insert Block
b - Power Piston
c - Spring

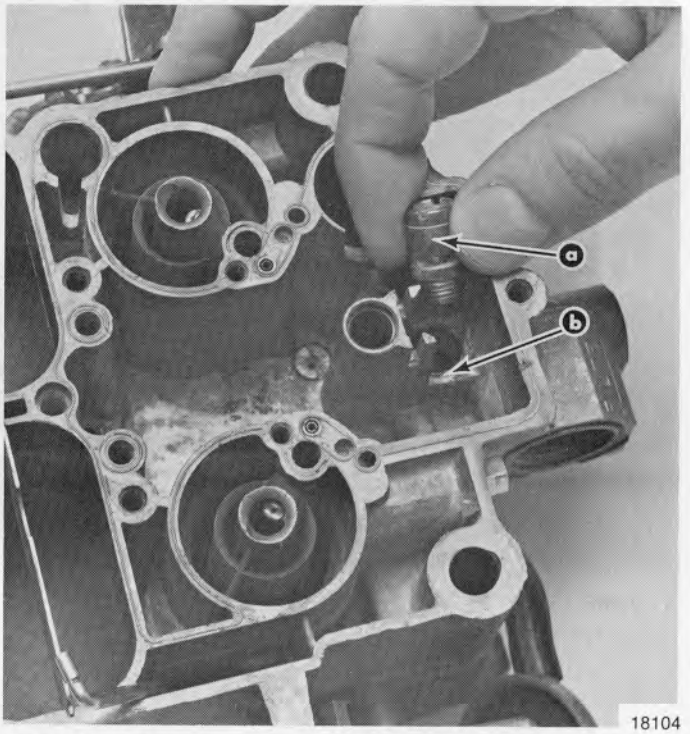
3. Remove float assembly, needle, and retaining pin.



18211

a - Float Assembly
b - Needle
c - Retaining Pin

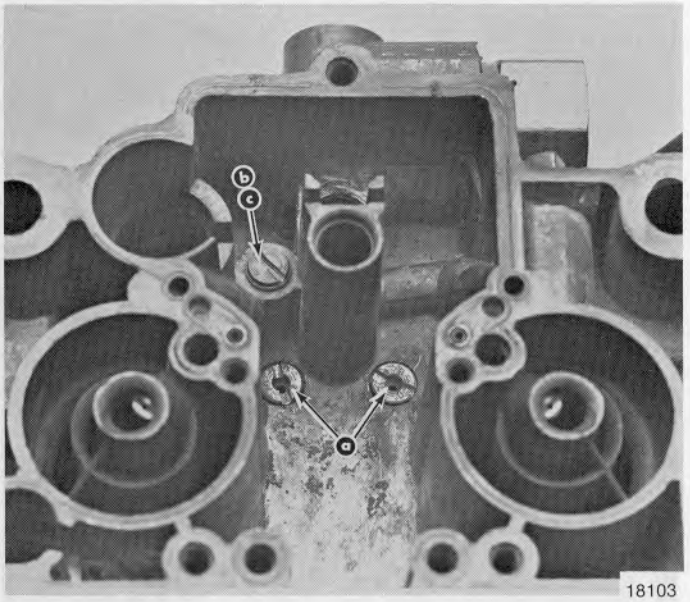
4. Remove fuel inlet seat and gasket.



18104

a - Fuel Inlet Seat
b - Gasket

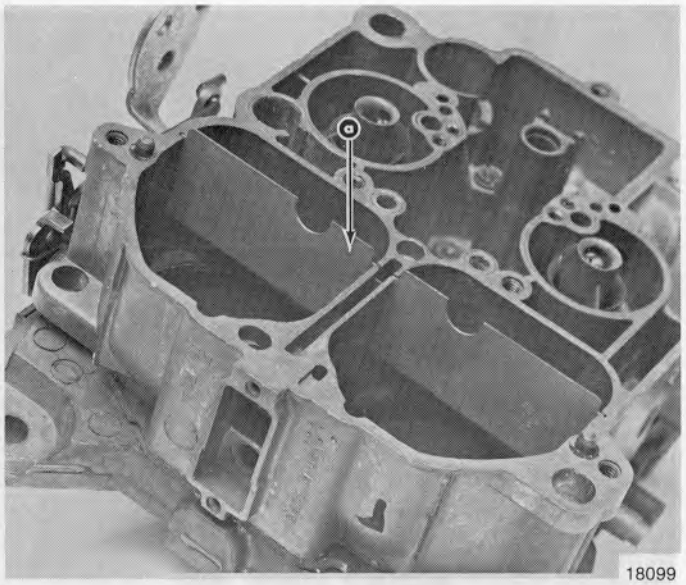
5. Remove primary metering jets, pump discharge check ball retainer and check ball.



18103

a - Primary Metering Jets
b - Pump Discharge Retainer
c - Check Ball (Not Visible)

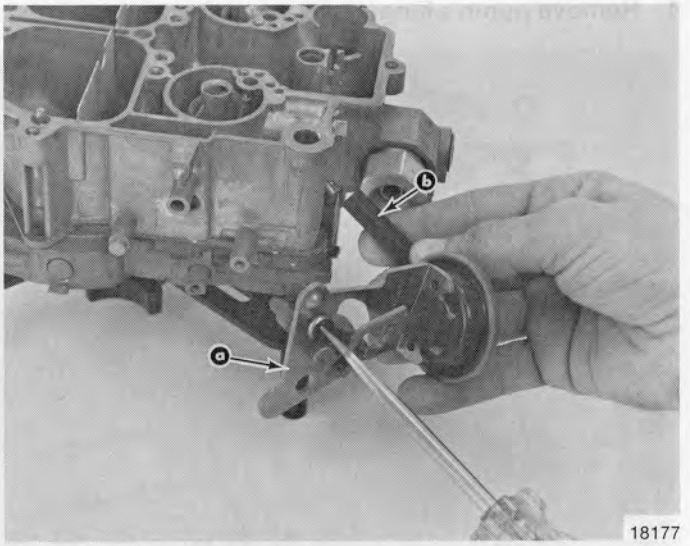
6. Remove baffle.



18099

a - Baffle

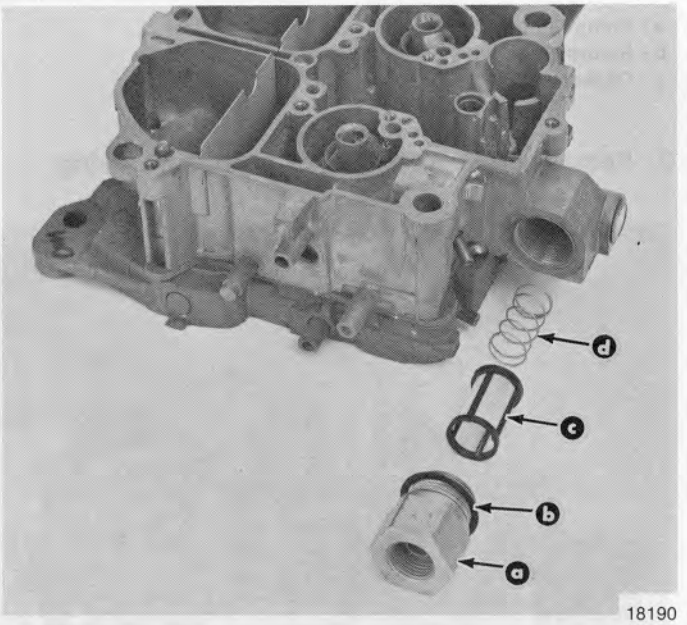
7. Remove vacuum control assembly, and hose.



18177

a - Vacuum Control Assembly
b - Hose

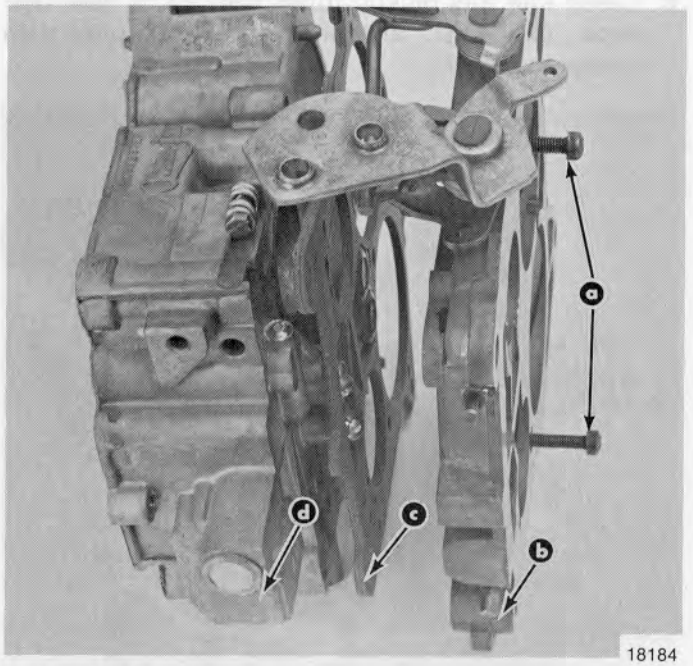
8. Remove fuel inlet filter nut, gaskets, filter and spring.



18190

a - Nut
b - Gaskets
c - Filter
d - Spring

9. Separate throttle body from float bowl and remove gasket.

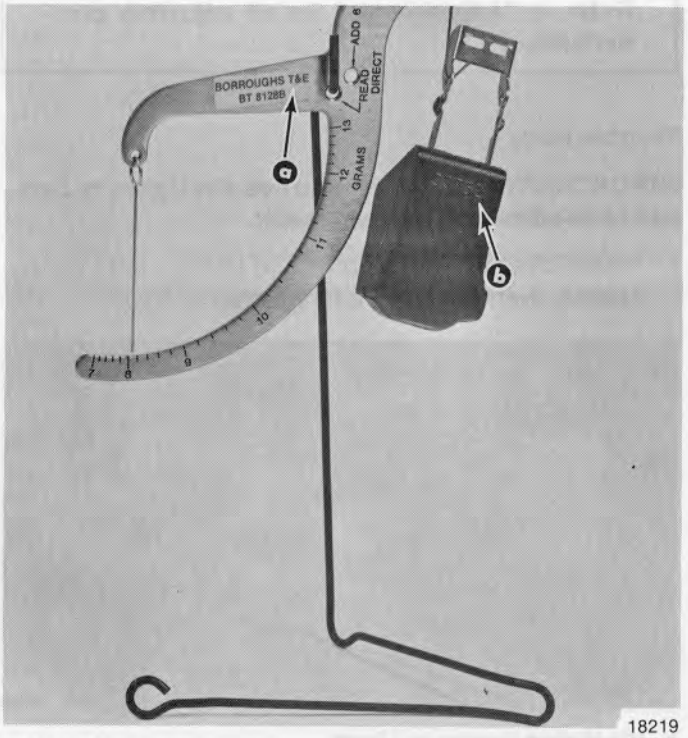


18184

a - Attaching Screws
b - Throttle Body
c - Gasket
d - Float Bowl

Float Weight

1. Assemble float scale to instructions with scale.
2. Check float weight to specifications.



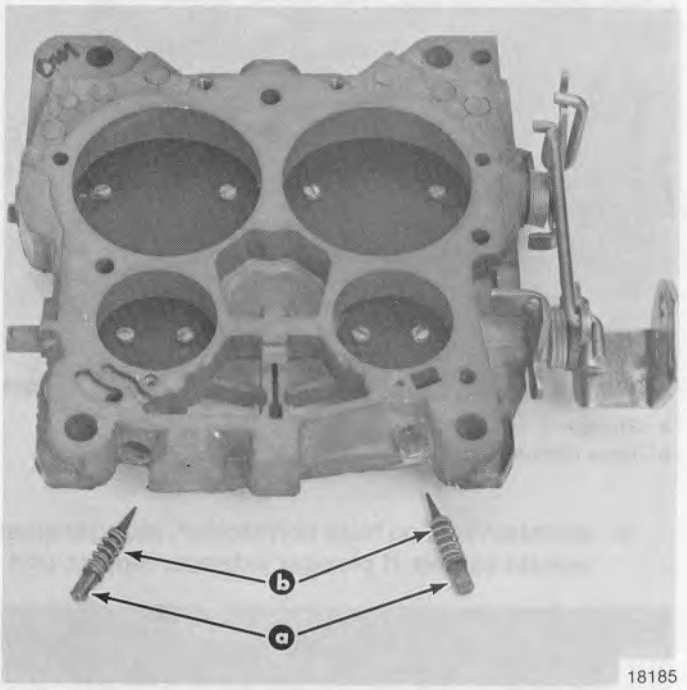
18219

a - Float Scale
b - Float

3. Replace float if not to specifications.

Throttle Body

1. Remove idle mixture screws and spring.



18185

a - Screw
b - Spring

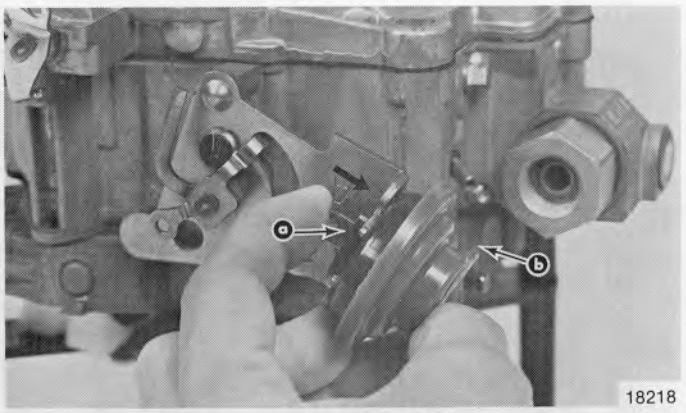
CLEANING and INSPECTION

⚠CAUTION
DO NOT leave carburetor in carb cleaner for more than two hours.

⚠CAUTION
Rubber, or plastic parts, pump plungers or diagrams cannot be immersed in carburetor cleaner. The Delrin air valve cam will withstand normal carburetor cleaner.

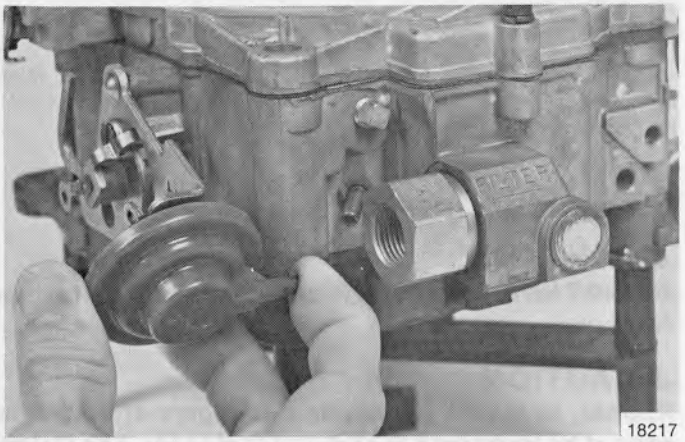
1. Clean carburetor in immersion type cleaner.
2. Blow out passages with compressed air. DO NOT drill thru passages.
3. Inspect for wear:
   a. Idle mixture needles
   b. Float needle and seat
   c. Casting surfaces
   d. All levers
   e. Fast idle cam
   f. Power piston
   g. Accelerator pump seal
4. Check all valves for binding.

5. Check vacuum break unit for leaks.
   a. Depress plunger and seal hose connection.



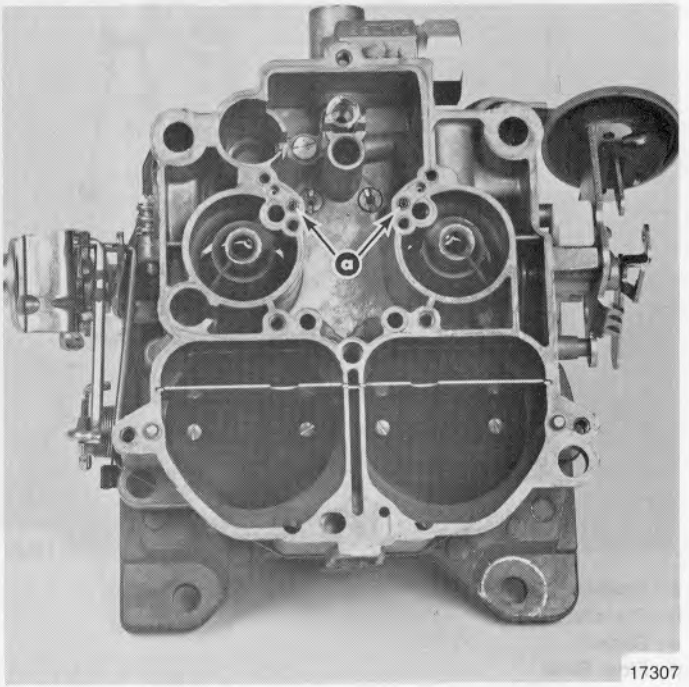
a - Plunger
b - Hose Connection

   b. Maintain seal on hose connection, plunger must remain seated. If plunger extends, replace unit.



IMPORTANT: The idle fuel pickup tubes have a smaller I.D. at the bottom than the top, DO NOT drill.

6. Clean idle fuel pickup tubes with a fine wire (approx. .020" O.D.) and blow out all channels with compressed air.



a - Idle Fuel Pickup Tube

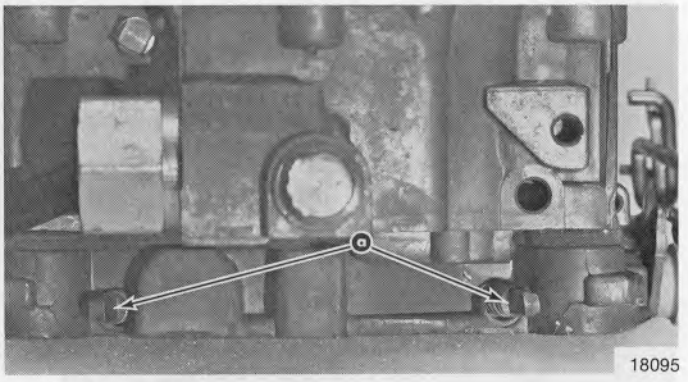
REASSEMBLY

NOTICE
Refer to "Adjustments" for all adjusting procedures.

Throttle Body

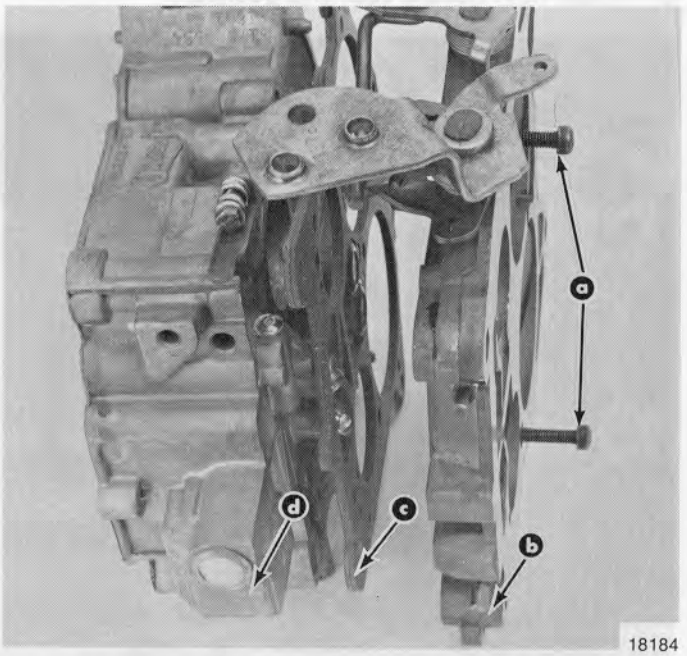
IMPORTANT: Seat idle mixture needles lightly or damage to needles and seat will result.

1. Install idle mixture needles and springs until lightly seated, then back out 2 to 3 turns.



a - Idle Mixture Needles and Seats

2. Install new gasket and assemble throttle body to float bowl, tighten securely.



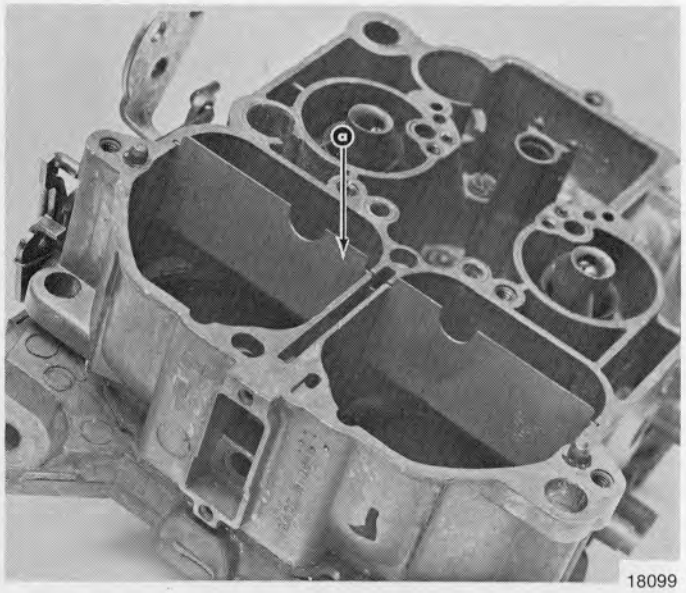
18184

a - Attaching Screws
b - Throttle Body
c - Gasket
d - Float Bowl

Float Bowl

IMPORTANT: Place carburetor on a holding fixture to prevent throttle valve damage.

1. Install baffle plate.

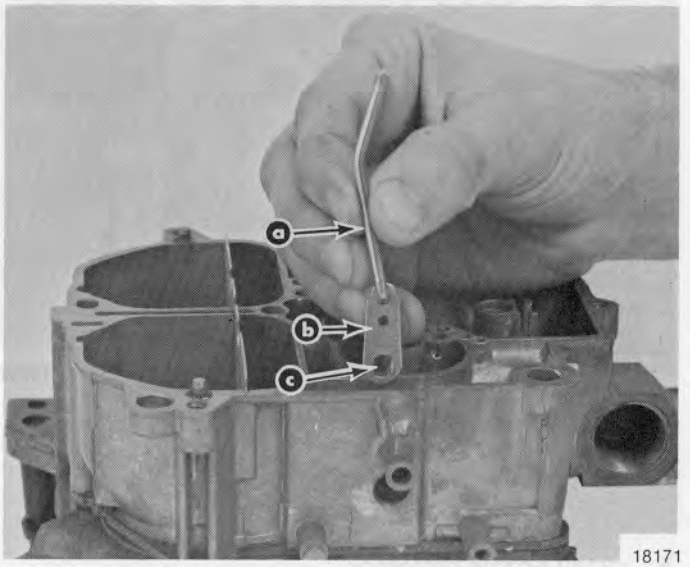


18099

a - Baffle Plate

2. Install intermediate choke lever and vacuum break control bracket assembly.

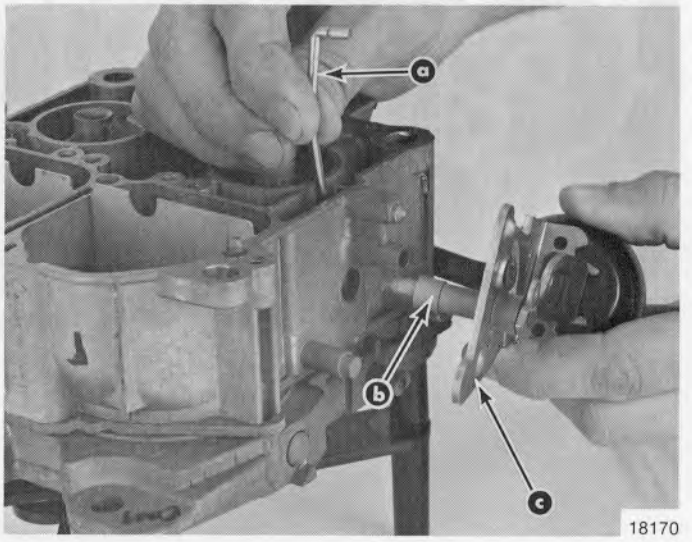
   a. Using choke rod, suspend intermediate choke lever in float bowl cavity so that flat sided hole aligns with hole in side of float bowl.



18171

a - Choke Rod
b - Choke Lever
c - Flat Sided Hole

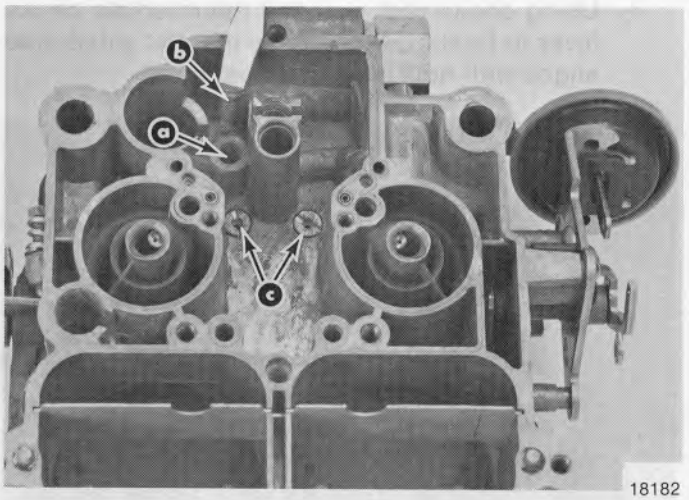
   b. Insert choke shaft on vacuum break control assembly to engage flat sided hole of choke lever, and secure with screw. Tighten securely.



18170

a - Choke Rod
b - Choke Shaft
c - Vacuum Break Control Assembly

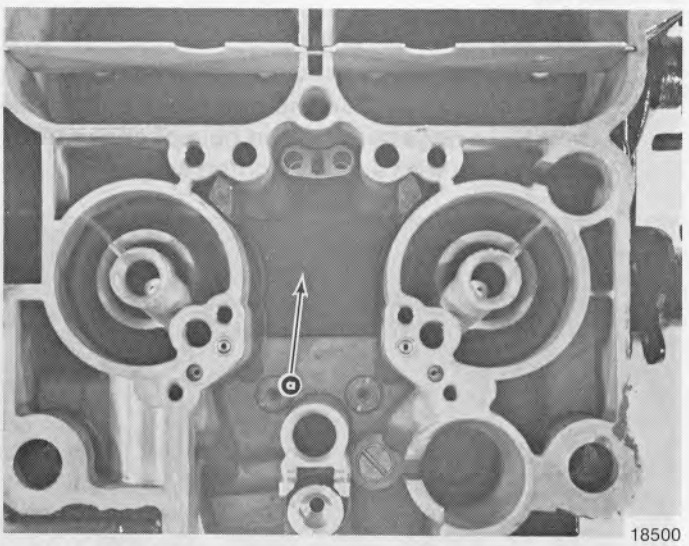
3. Install pump discharge check ball, retainer and primary main metering jets, tighten securely.



18182

a - Check Ball (Not Shown)
b - Retainer
c - Primary Main Metering Jets

4. Install nozzle deflector.

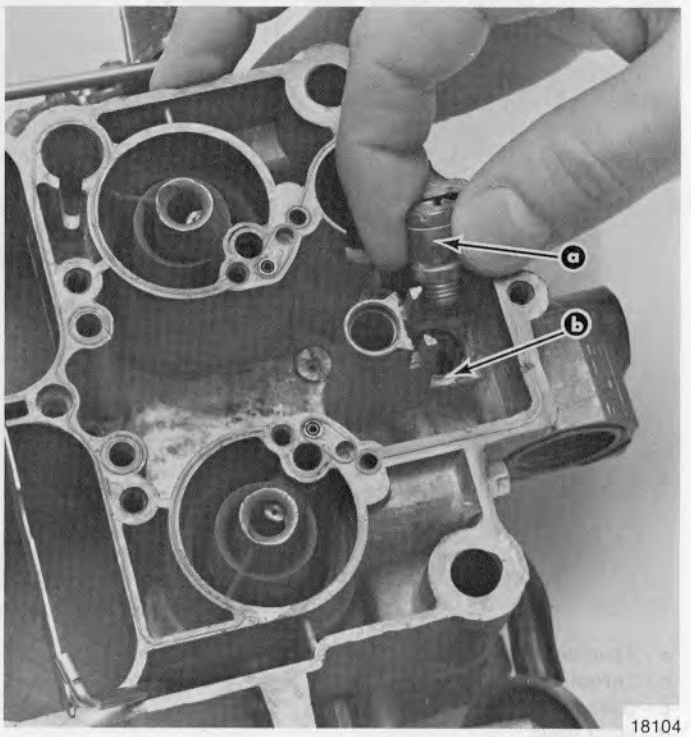


18500

a - Nozzle Deflector

IMPORTANT: Float needle and seat should be replaced as a set only.

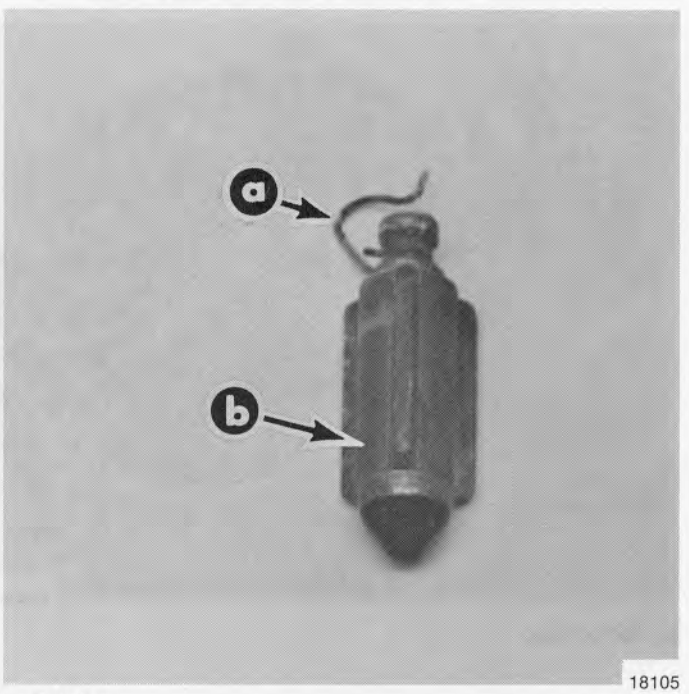
5. Install float needle seat and gasket.



18104

a - Float Needle Seat
b - Gasket

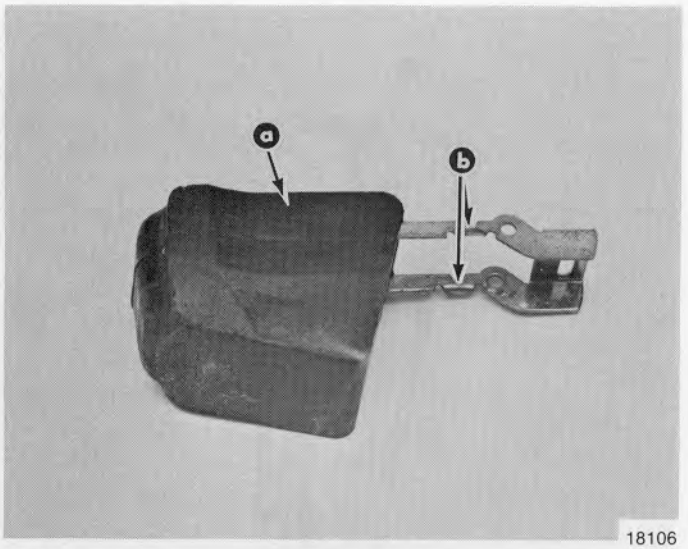
6. Installing float needle and float assembly.
   a. Install pull clip onto needle.



18105

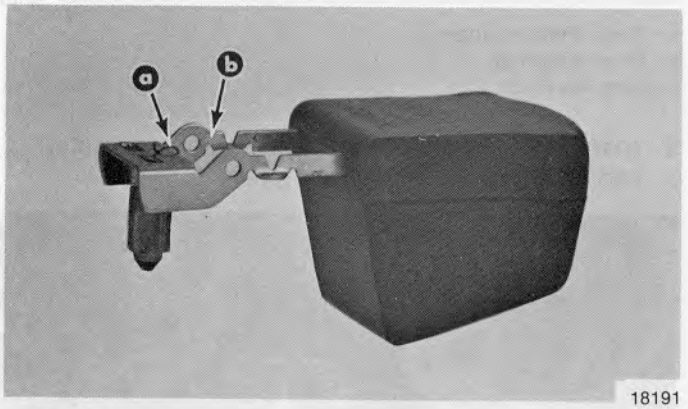
a - Pull Clip
b - Needle

b. If a new float or needle and seat are used, bend float arm upward at notch for easier adjustment.



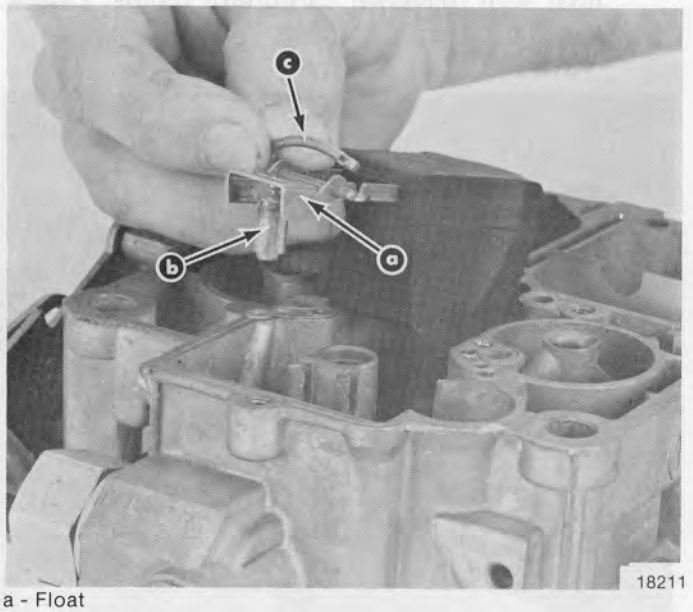
a - Float
b - Float Arm Notch

c. Hook needle pull clip over edge of float arm closest to pontoon.



a - Pull Clip
b - Float Arm

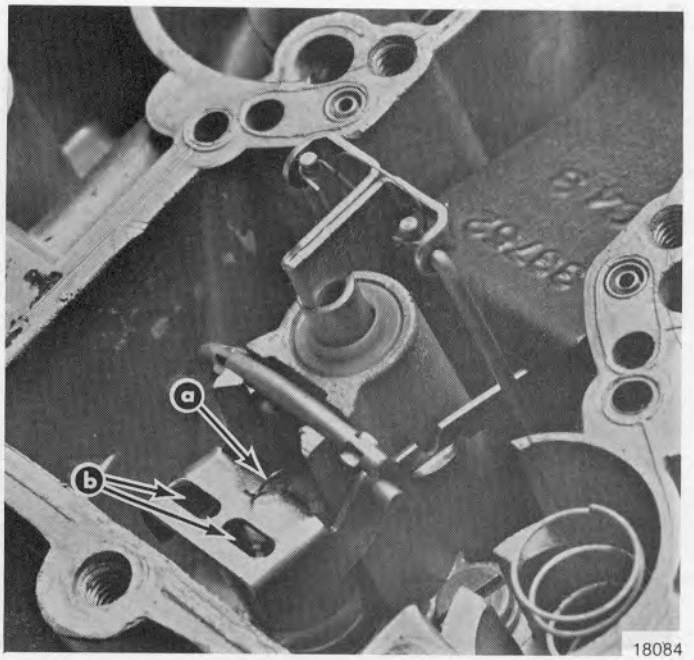
d. Install retaining pin into float arm and install float and needle into bowl.



a - Float
b - Needle
c - Hinge Pin

IMPORTANT: Top of hinge pin must extend above casting by .010" for pin retention.

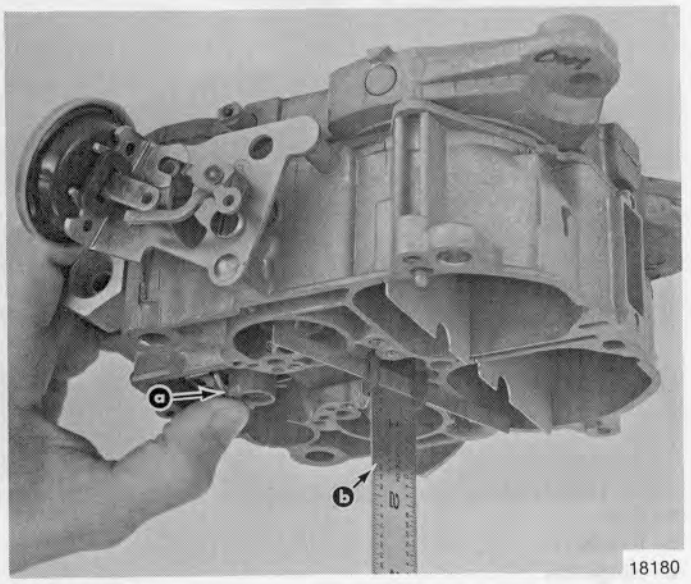
IMPORTANT: DO NOT install pull clip in either hole because needle will not seat properly.



a - Hook over end of float arm
b - DO NOT hook in these holes

Pull Clip Installation

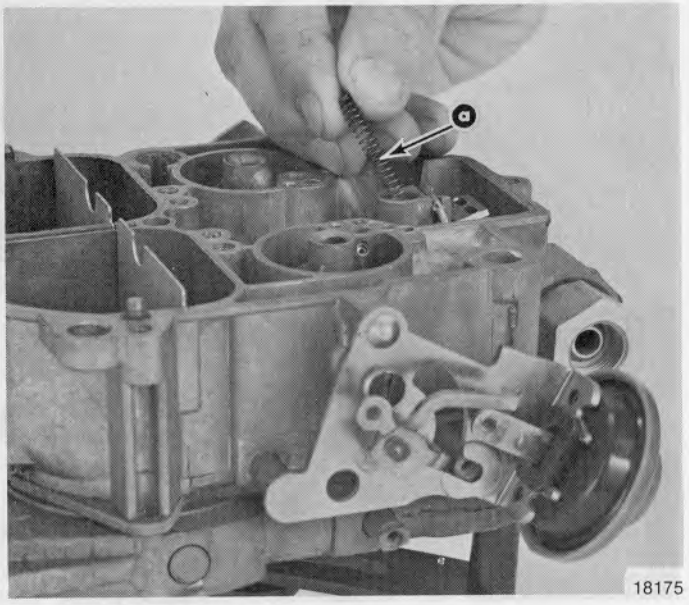
e. Hold hinge pin firmly, turn carburetor upside down and measure from casting surface to toe of float with universal carburetor gauge. Check specifications.



a - Hinge Pin
b - Universal Carburetor Gauge

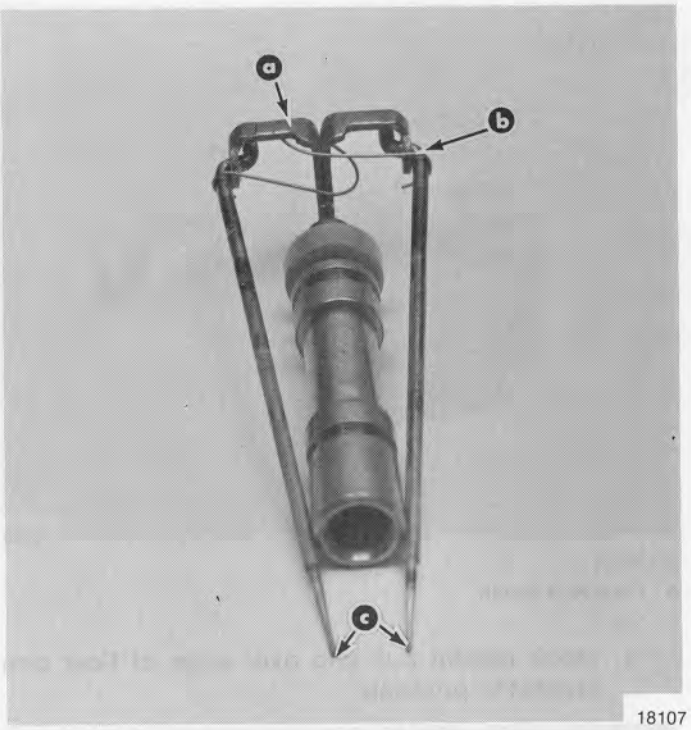
f. Bend at float arm notch for adjustment to specifications.

7. Install power piston spring.



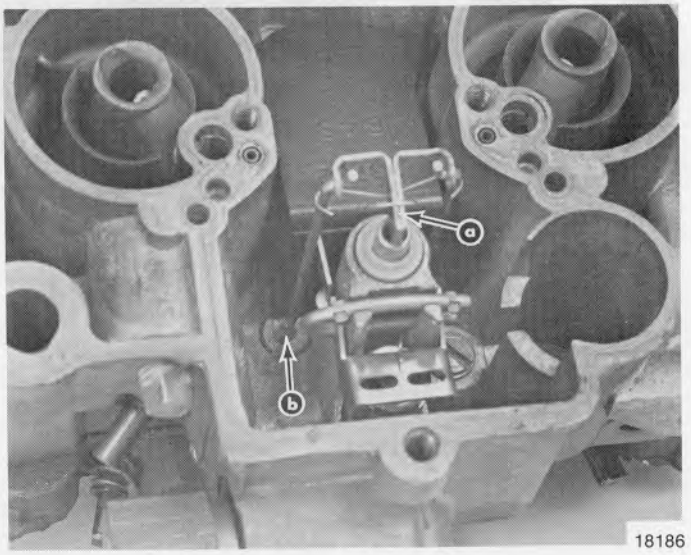
a - Power Piston Spring

8. Install primary main metering rods in power piston hanger, and connect spring as shown.



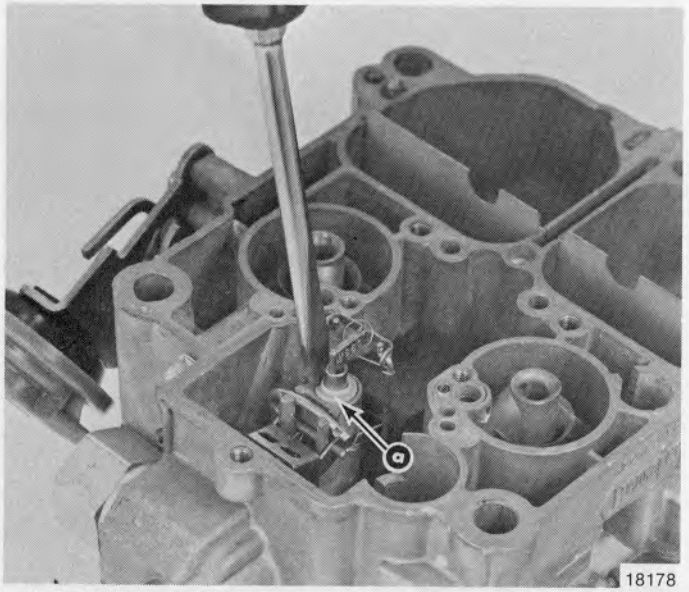
a - Power Piston Hanger
b - Tension Spring
c - Metering Rods

9. Install power piston assembly, guiding metering rod tips into main metering jets.



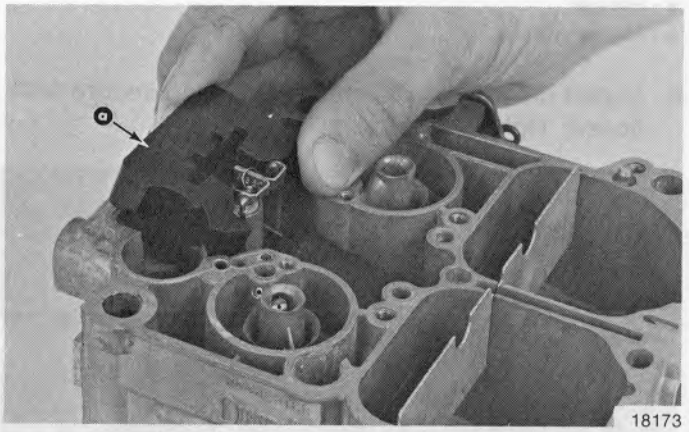
a - Power Piston Assembly
b - Metering Rod Tip in Main Metering Jet

10. Push power piston retainer down until flush with casting.



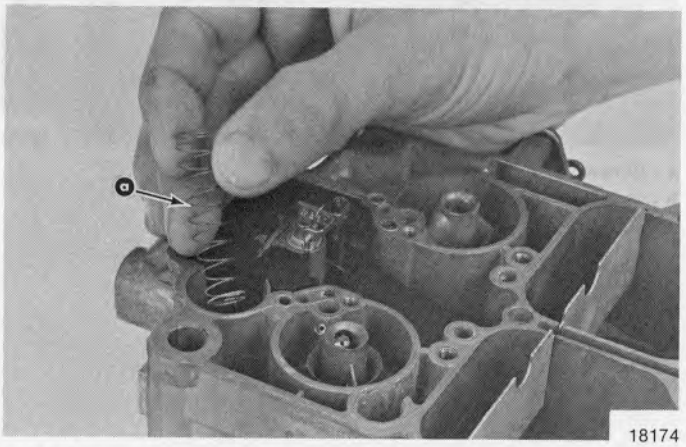
a - Power Piston Retainer

11. Install filler block.



a - Filler Block

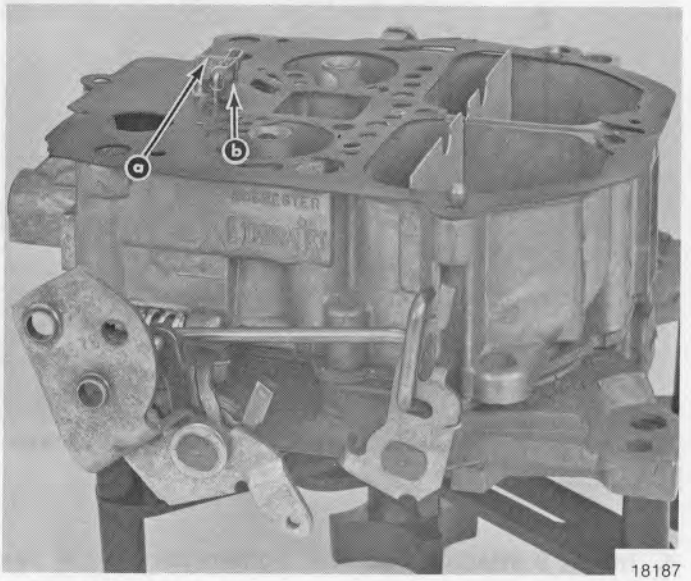
11. Install accelerator pump plunger spring.



a - Spring

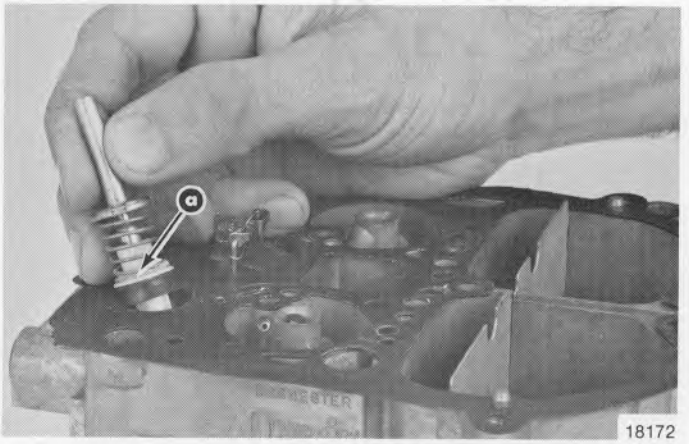
Air Horn

1. Install new gasket and slide tab under power piston hanger.



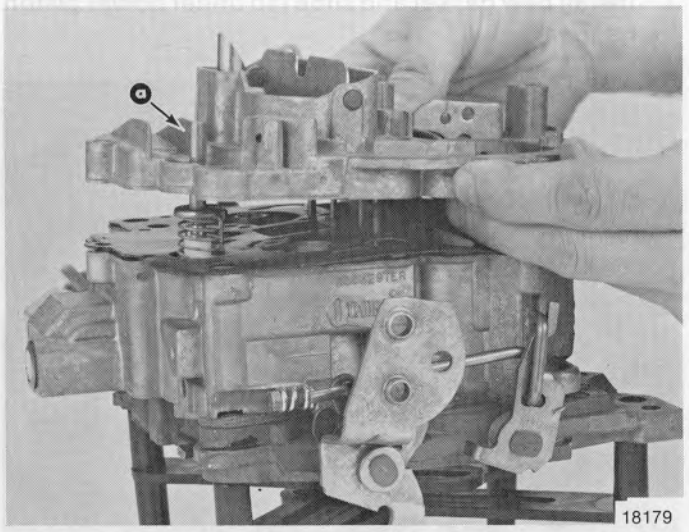
a - Power Piston Hanger
b - Gasket Tab

2. Install accelerator pump plunger.



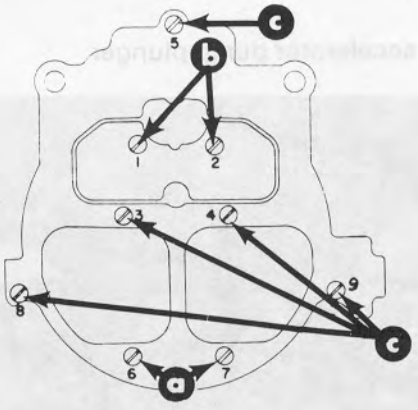
a - Plunger

3. Install air horn.



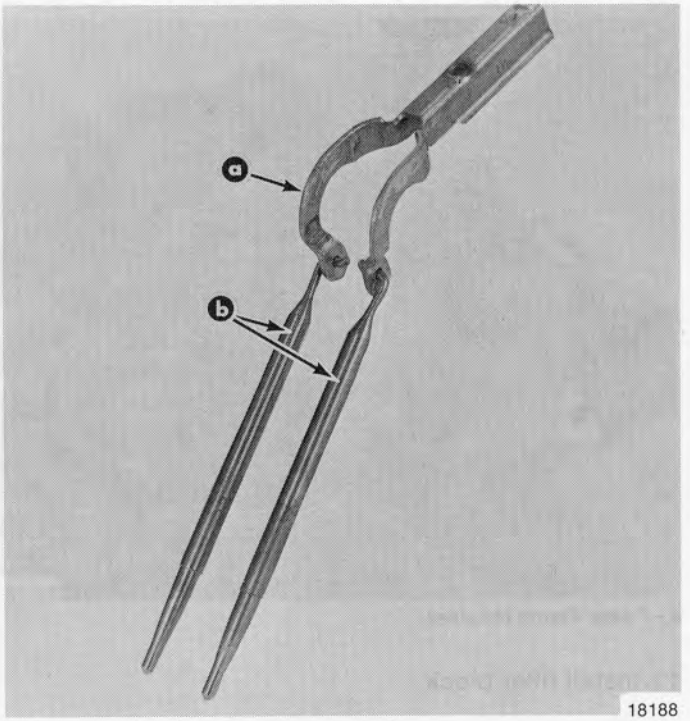
a - Air Horn

4. Install 9 attaching screws, tighten securely in sequence as numbered.



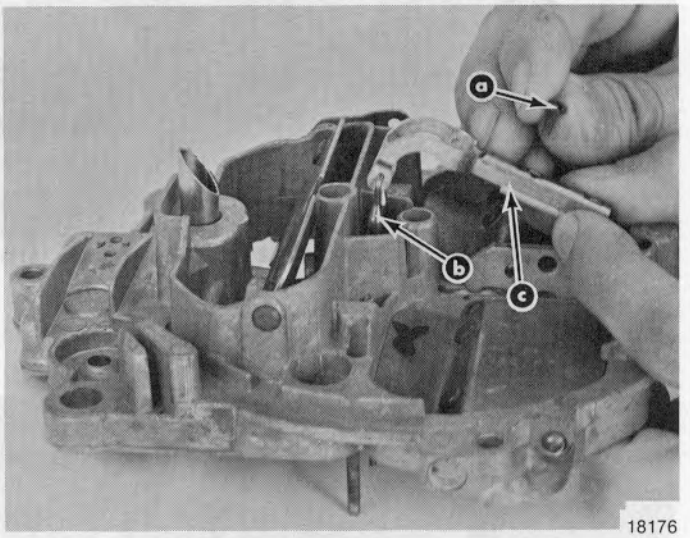
a - Long
b - Short
c - Countersunk

5. Install secondary metering rods into hanger with upper ends toward each other as shown.



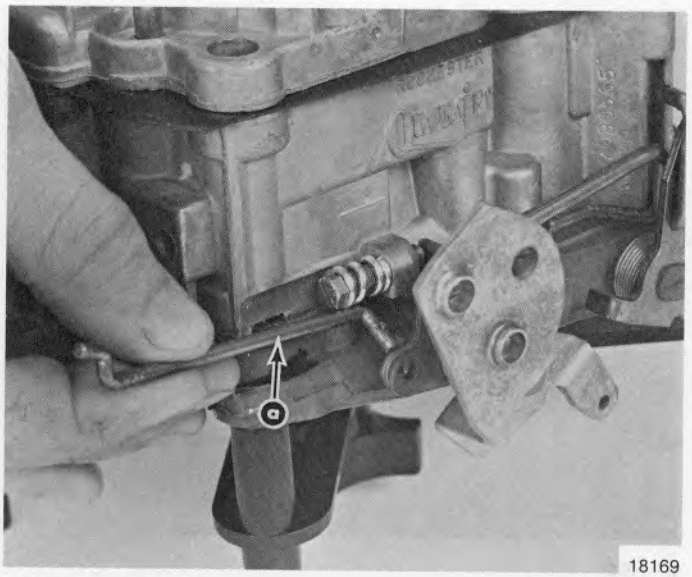
a - Hanger
b - Metering Rods

6. Install metering rods and hanger and secure with screw. Tighten securely.



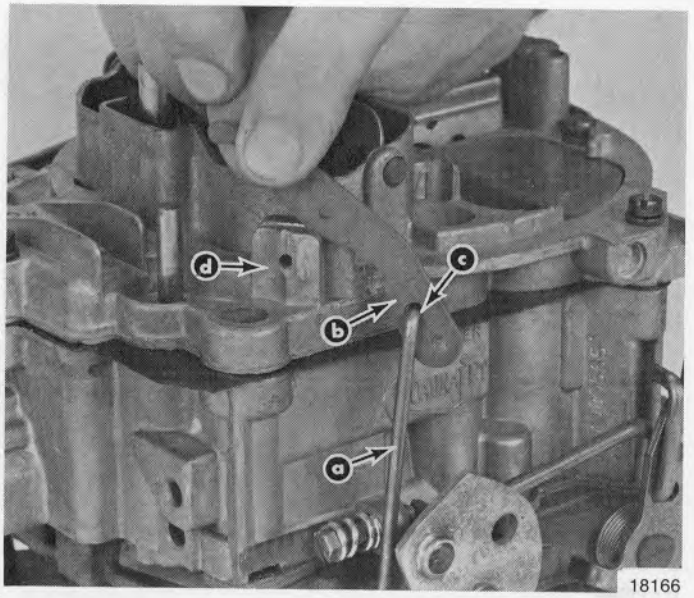
a - Screw
b - Metering Rods
c - Hanger

7. Install pump lever rod.



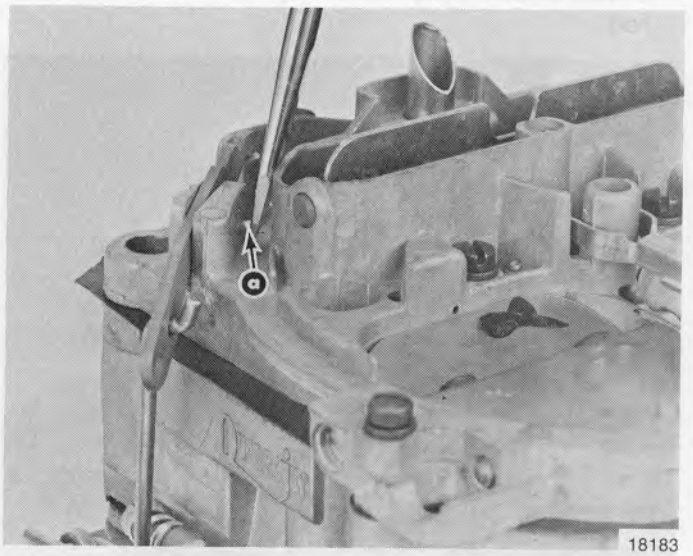
a - Pump Lever Rod

8. Install rod into lever inner hole and place lever into casting mount.



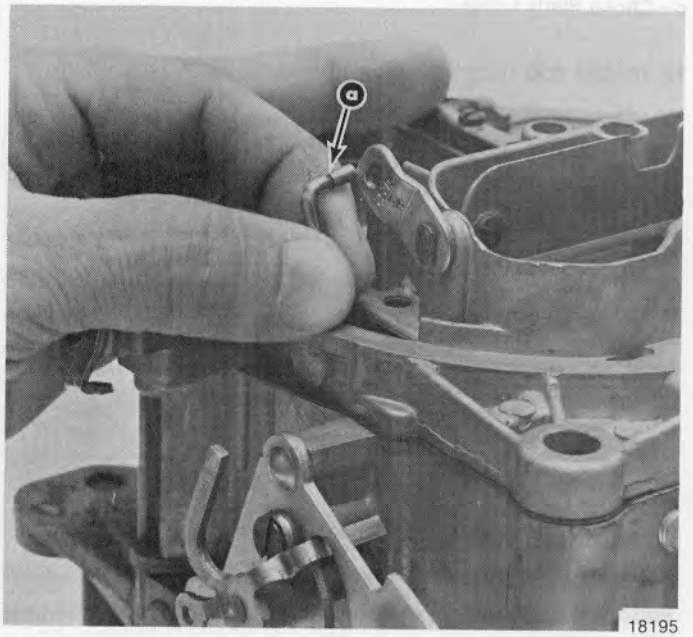
a - Rod
b - Lever
c - Inner Hole
d - Casting Mount

9. Press roll pin into place using a screwdriver.



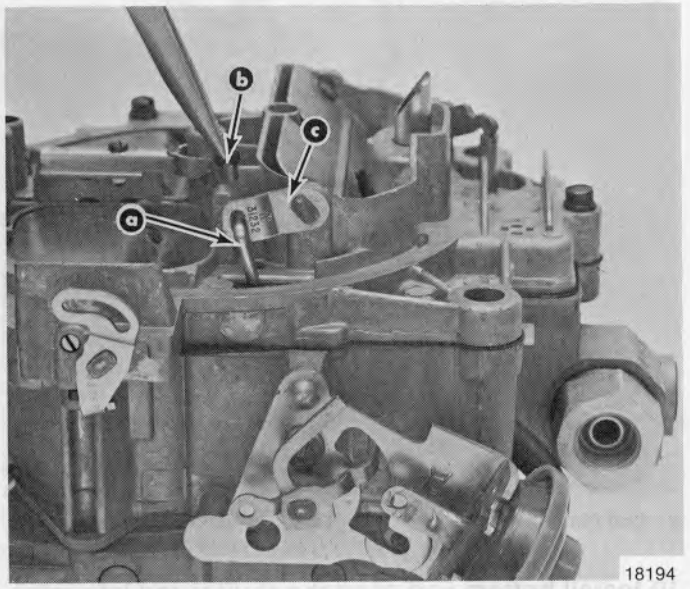
a - Roll Pin

10. Install bottom end of choke shutter rod into intermediate choke lever in float bowl.



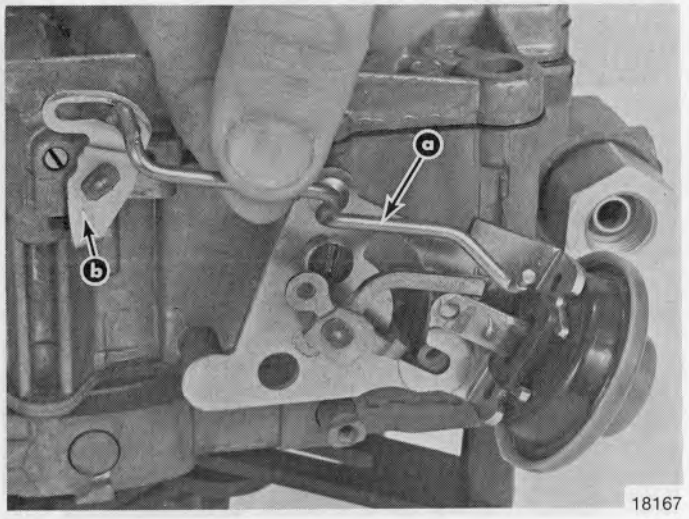
a - Choke Shutter Rod

11. Install upper end of choke shutter rod into the choke blade lever, install clip onto choke shutter rod.



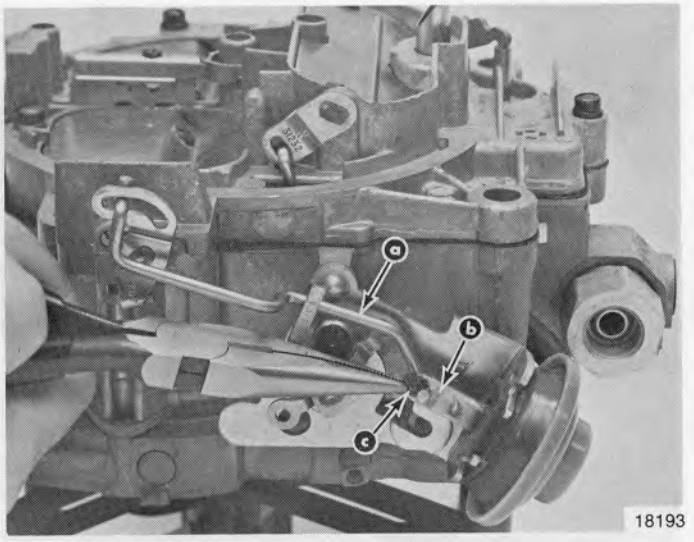
a - Choke Shutter Rod
b - Clip
c - Choke Blade Lever

12. Install rod into air valve lever.



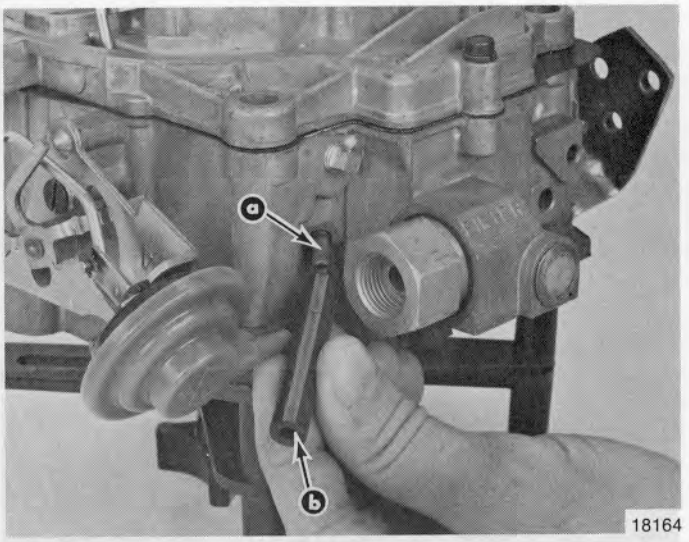
a - Rod
b - Air Valve Lever

13. Install rod into vacuum break arm and install clip.



a - Rod
b - Vacuum Break Arm
c - Clip

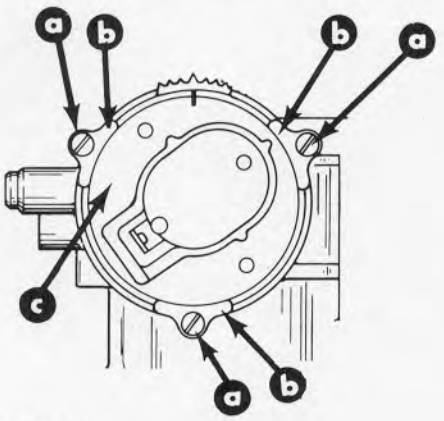
14. Install vacuum break hose onto carburetor fitting.



a - Fitting
b - Hose

ELECTRIC CHOKE

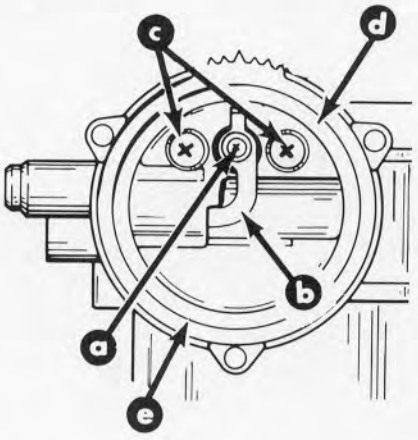
1. Install choke housing assembly. Tighten securely.



384-H

a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly
d - Gasket - If Equipped (Not Visible)
e - Choke Housing Assembly

2. Install choke lever and screw. Tighten securely.
3. Install choke cover, retainers, lockwashers, and screws. Adjust choke to specifications. Tighten screws securely.



384-H

a - Screws
b - Retainer
c - Choke Cover

INSTALLATION

1. Clean gasket surfaces.
2. Place NEW carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque nuts evenly to specifications.

NOTE: If carburetor was disassembled install filter, spring, washers, and filter nut.

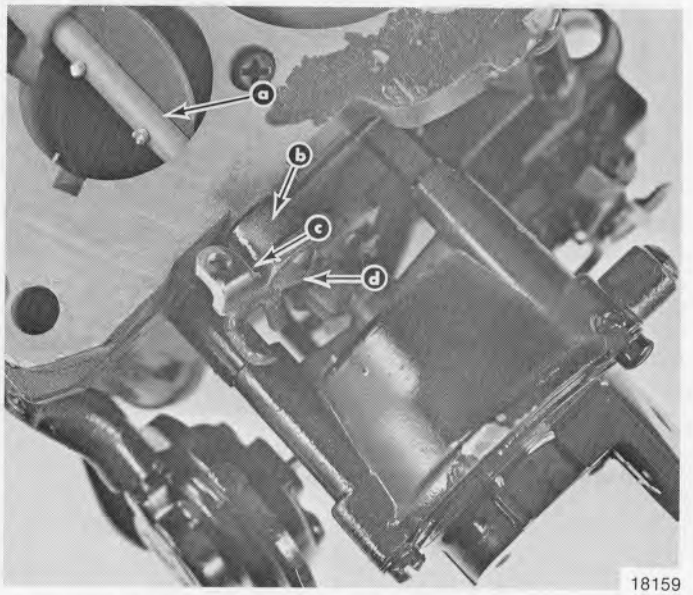
3. Connect fuel line to fuel inlet nut and torque to specifications.
4. Connect fuel pump vent hose to fitting on carburetor.
5. Connect electric choke connections to choke cover.
6. Install throttle cable, as outlined.
7. Install flame arrestor and crankcase ventilation hose.
8. Reconnect battery cables to battery.
9. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
10. Adjust idle speed and idle mixture, as outlined.

Service Information

4MC CARBURETOR MERCURY NUMBER, 1347-9142 (Rochester Number 17083522)

IMPORTANT: The MCM 190MR 4MC carburetor 17083522 supercedes the original 488R 4MC carburetor 17081299. There were several changes made on the 17083522 carburetor that must be addressed.

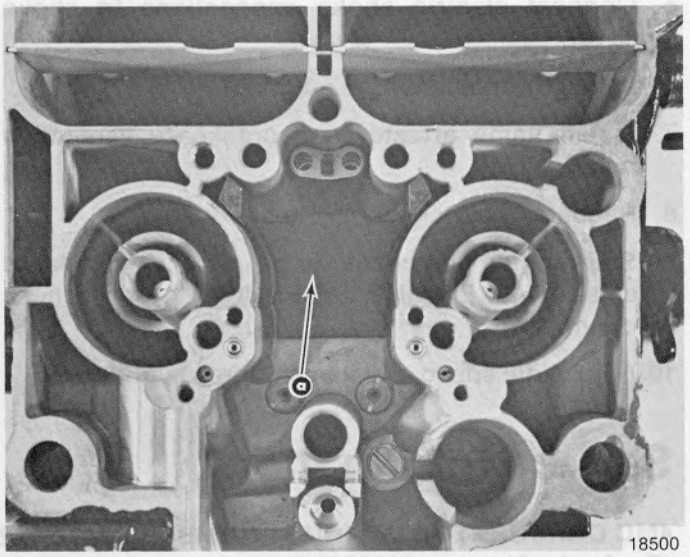
1. Modifying (17083522) Rochester carburetor for use on MCM 488.
   a. Before installing the (17083522) carburetor on MCM 488 remove and discard the choke pull-off lever, spacer and screw. These parts must be removed because they will hit the 10° wedge when installing the carburetor.



18159

a - Throttle Shaft
b - Spacer
c - Lever
d - Screw
— Remove and Discard

2. The 17083522 Rochester carburetor has a nozzle deflector installed in the float bowl.

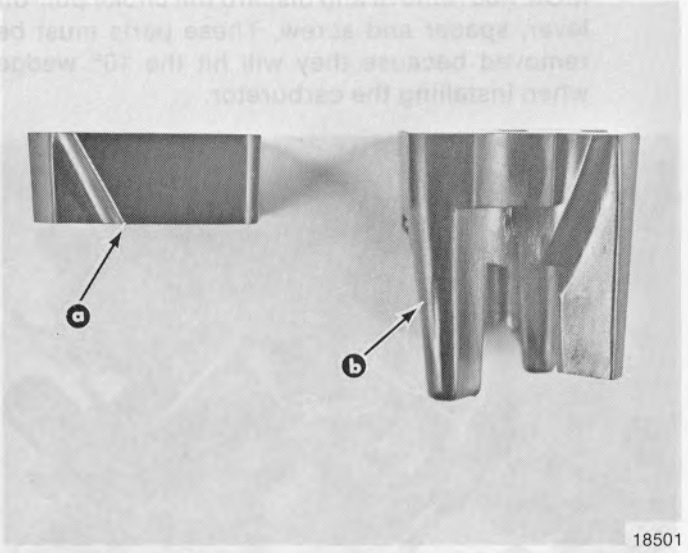


a - Nozzle Deflector

IMPORTANT: When installing the 17083522 Rochester carburetor on a 488R with a 10° wedge the nozzle deflector can be used.

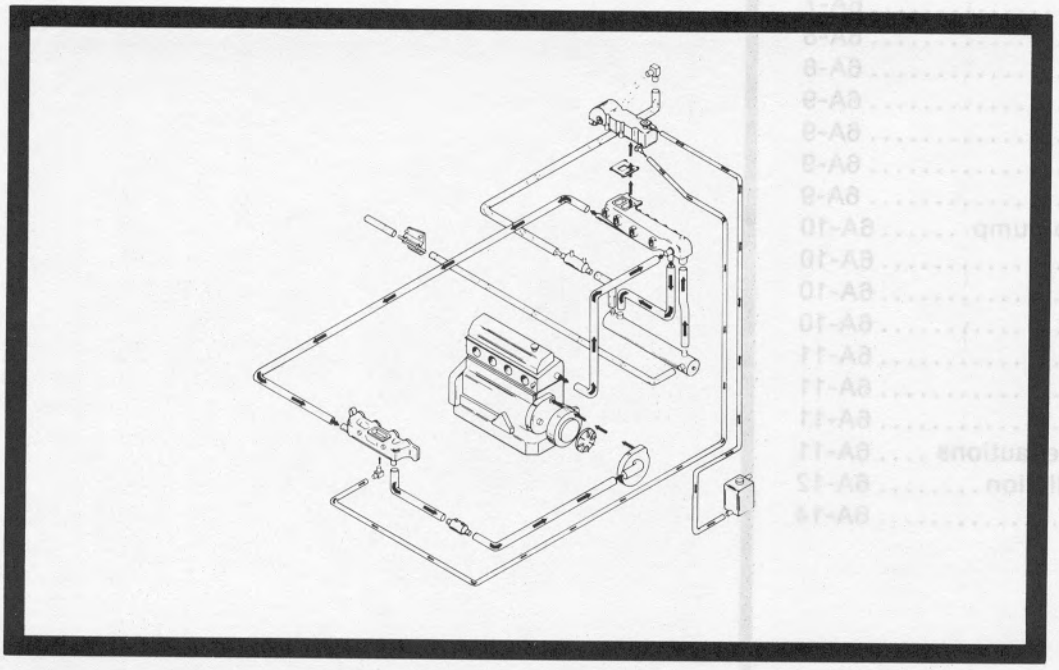
FILLER BLOCKS

1. There are 2 types of filler blocks used.



a - Short Filler Block Used on All 4MV V-8 Carburetors
b - Long Filler Block Used on 4MC 488/190 Carburetors

COOLING and EXHAUST



STANDARD COOLING
224 CID (3.7L)

6

A

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Torque Specifications	6A-1
Lubricants/Sealants	6A-1
Specifications	6A-1
Description	6A-1
Maintaining Coolant Level	6A-2
Troubleshooting the Cooling System	6A-2
Testing System	6A-4
Testing Coolant for Alkalinity	6A-4
Pressure Testing System	6A-4
Testing for Cylinder Head Gasket Leak	6A-5
Testing Heat Exchanger	6A-5
Testing Pressure Cap	6A-5
Heat Exchanger Repair	6A-7
Thermostat	6A-7
Removal	6A-7
Testing	6A-7
Identification	6A-8
Installation	6A-8
Changing Coolant	6A-9
Coolant Recommendation	6A-9
Change Intervals	6A-9
Draining Precautions	6A-9
Stern Drive Unit Seawater Pickup Pump	6A-10
Cleaning System	6A-10
Closed Cooling Section	6A-10
Seawater Section	6A-10
Filling Closed Cooling Section	6A-11
Out-of-Season Storage	6A-11
Closed Cooling Section	6A-11
Seawater Section Draining Precautions	6A-11
Auxiliary Hot Water Heater Installation	6A-12
Cooling System Flow Diagrams	6A-14

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
4" (102mm) Dia. Heat Exchange End Cap		120-140 (13.6-15.8)
Hose Clamps	Securely	
Exhaust Elbow/Reservoir	30 (41)	
Thermostat Housing	20 (27)	
Heat Exchanger Mounting Brackets	Securely	
Drain Plugs	Securely	

Lubricants/Sealants

LUBRICANTS/SEALANTS	
92-86154A1	Quicksilver 2-4-C Marine Lubricant
92-34227-1	Quicksilver Perfect Seal

Specifications

CLOSED COOLING SYSTEM CAPACITY	
Model	**Qts. (Litres) Approximately**
(102mm) Dia. Heat Exchanger	11 (10.4)

THERMOSTAT	
All Models	160° F (71° C)

PRESSURE CAP	
All Models	14 PSI (97 kPa)

Description

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile. The closed cooling system is similar in function to the rest of the cooling system in an automobile with the heat exchanger functioning as the radiator. The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck. The air bleed system is designed to reduce or remove aeration which occurs during filling, or slight head gasket leakage. The system operates by producing a small flow through the reservoir which allows coolant/air bubbles to separate and vent off while passing through the reservoir. For the system to operate properly, the small hose and fittings going from the reservoir to the exhaust (or intake manifold) must not be plugged.

Maintaining Coolant Level

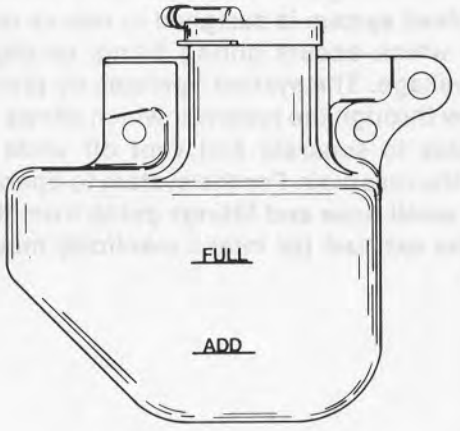
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1" (25mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

2. Coolant level should be between the "Add" and "Full" mark on coolant recovery reservoir with engine at normal operating temperature.



193-HR

Troubleshooting the Cooling System

The following is a general guide to troubleshoot the closed cooling system used on MerCruiser 4 Cylinder 224 CID Engines (170/190).

1. The seawater circuit has one prime cause of trouble: reduced water flow (similar to reduced air flow in an automobile). The most common causes of reduced seawater flow:
   a. Bad seawater pump impeller.
   b. Kinked or loose hoses.
   c. Impeller blade or debris in drive/transom assembly water passages.
   d. Blockage in heat exchanger (seawater circuit).
   e. Blocked exhaust elbow.
   f. Improperly repaired heat exchanger.
   g. Hose fitting in exhaust elbow installed too deep.
2. The closed cooling circuit can have trouble from three different causes: Loss of coolant, reduced coolant flow and aeration of coolant. The most common causes of the three different problems in the closed cooling circuit are as follows:

   Loss of Coolant

   a. Loose hoses.
   b. Damaged pressure cap.
   c. Leaking heat exchanger.
   d. Cracked or warped cylinder head.
   e. Improperly installed gaskets between exhaust manifold and exhaust elbow.
   f. Cracked manifold.
   g. Worn seals on circulating pump.
   h. Cylinder block porosity.

   Reduced Flow

   a. Thermostat failure or automotive thermostat being used.
   b. Aeration.
   c. Blockage in heat exchanger (closed cooling circuit).
   d. Loose circulating pump impeller.
   e. Collapsing hoses.

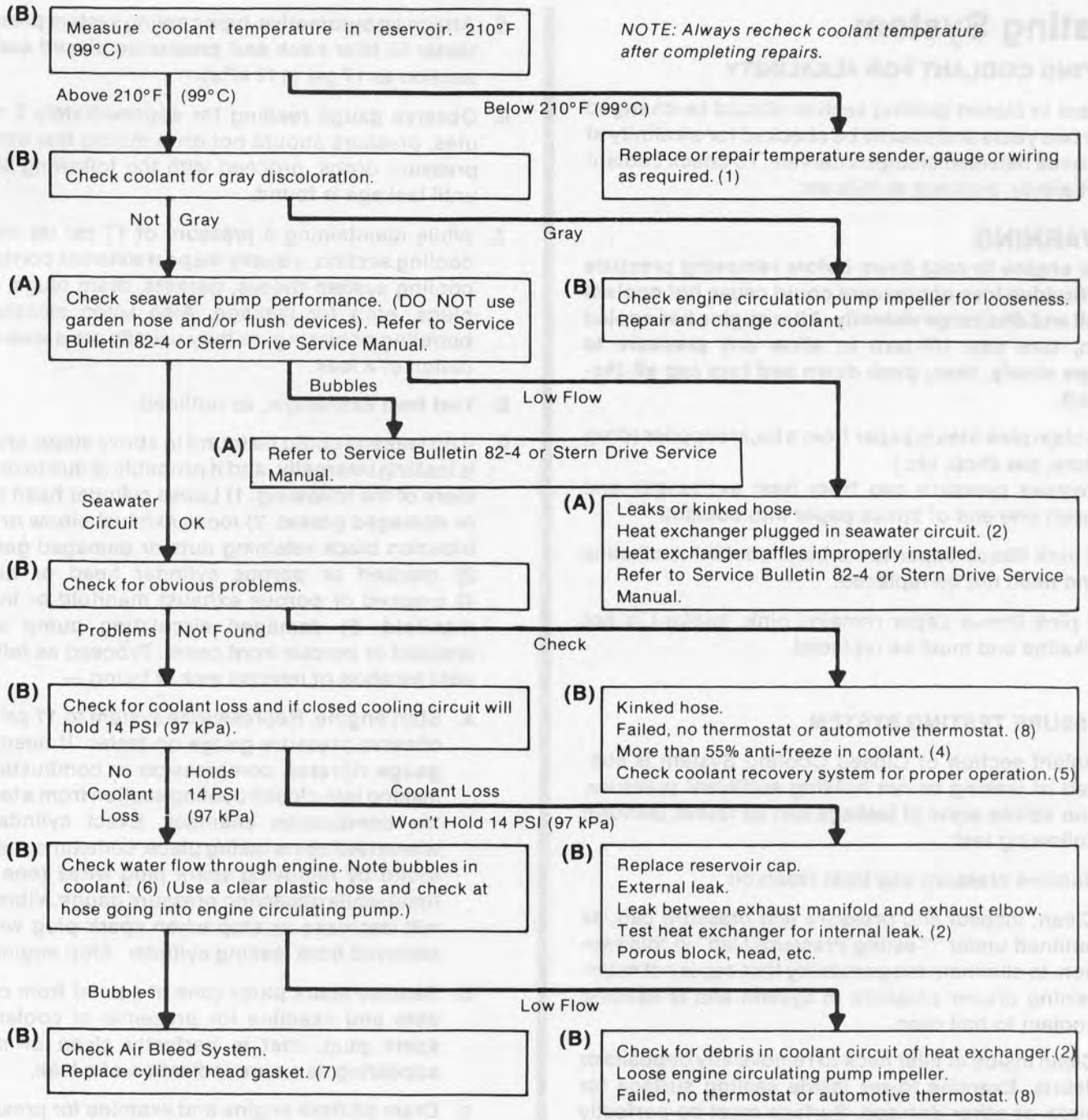
   Aeration

   a. Improper filling.
   b. Leaking cylinder head gasket.

   Although the cause of trouble can occur individually, two or three of them usually show up together. All result in an increase in engine temperature. In the following chart, (A) refers to the seawater circuit and (B) refers to the closed cooling circuit.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.



NOTE: Always recheck coolant temperature after completing repairs.

Note 1: Normal operating engine temperature taken at the water temperature sender with a direct reading gauge is 165° F (74° C) to 200° F 93° C) at W.O.T. Dual station boats must use a dual station water temperature sender.

Note 2: Refer to "Testing" Heat Exchanger.

Note 3:

Note 4: % of anti-freeze in coolant can be checked with anti-freeze tester.

Note 5: Refer to "Coolant Recovery and Air Bleed Systems Operation".

NOTE 6: Run in lake for this test.
Note coolant color in clear plastic hose and reservoir before starting engine. Coolant is dark in color. Start engine and run at 3500 RPM.
Normal: *Coolant is dark in color (near the color before starting engine) with some air bubbles.*
Abnormal: *Coolant becomes very light in color because of many bubbles.*

NOTE 7: Refer to "Testing for Cylinder Head Gasket Leak".

NOTE 8: Automotive thermostats CANNOT BE USED in these engines because they DO NOT direct the coolant flow to the heat exchanger when thermostat is open.

Testing System

TESTING COOLANT FOR ALKALINITY

Coolant in closed cooling section should be changed every two years and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. If pink litmus paper turns blue, coolant is alkaline and need not be replaced.
4. If pink litmus paper remains pink, coolant is not alkaline and must be replaced.

PRESSURE TESTING SYSTEM

If coolant section of Closed Cooling System is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under "Testing Pressure Cap" in this section, to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also, check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in closed cooling section to 1" (25mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to 17 psi (117 kPa).
6. Observe gauge reading for approximately 2 minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining a pressure of 17 psi on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, core plugs, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Test heat exchanger, as outlined.
9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: 1) Loose cylinder head bolts or damaged gasket, 2) loose exhaust elbow or distribution block retaining nuts or damaged gasket, 3) cracked or porous cylinder head or block, 4) cracked or porous exhaust manifold or intake manifold, 5) damaged circulating pump seals cracked or porous front cover. Proceed as follows until location of internal leak is found —
   a. Start engine. Repressurize system to 17 psi and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinder(s), where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when spark plug wire is removed from leaking cylinder. Stop engine.
   b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug, that is perfectly clean or milky appearing, is a sure indication of a leak.
   c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky, if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, repressurize closed cooling section to 17 psi and examine internal surfaces of engine to locate leak.
   d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

TESTING FOR CYLINDER HEAD GASKET LEAK

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor; and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91cm) long hose for this test.
2. Route this hose so a "U" is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13cm) of the "U".
4. Observe the "U" while the engine is running.
   a. During idle and warm-up: some coolant and/or air will leave the reservoir.
   b. During cruising speed (2500-3500 RPM): coolant and/or air leaving the reservoir should stop after approximately 5 minutes running at a given RPM. A leaking head gasket will produce air bubbling through the "U", going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
   c. At higher speeds (4000+ RPM): Normal operation is the same as described in "b" above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant leaving the reservoir.

   It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately 5 minutes at a given RPM. A head gasket leak will not stop - the one thing that marks a failed head gasket is the continued passage of air, that may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

TESTING HEAT EXCHANGER

For Internal Leak: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

a. Remove a seawater hose from the exchanger. Do not drain the exchanger.
b. Pressurize the closed cooling circuit to 14-20 PSI (97-138 kPa) with a radiator tester.
c. If seawater begins to overflow from the nipple there is a leak.

For Blockage:

IMPORTANT: Seawater flows through the tubes in the exchanger. Closed cooling coolant flows around the tubes.

a. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
b. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

TESTING PRESSURE CAP

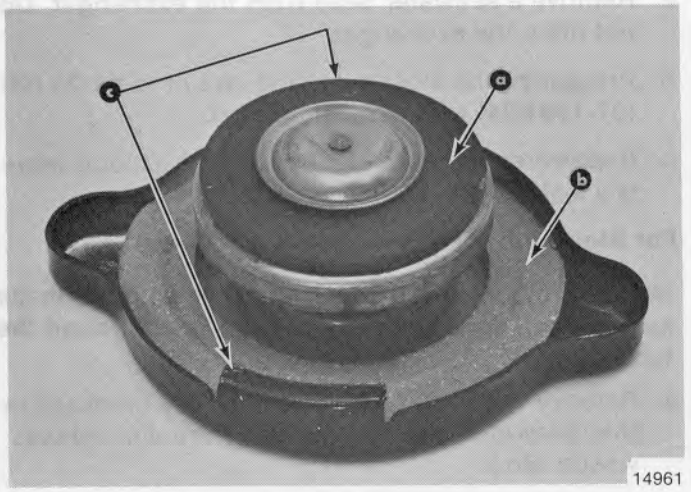
Pressure cap is designed to maintain a pressure of approximately 14 psi (97 kPa) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure, as follows:

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Carefully remove pressure cap from reservoir.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.

3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap, if rubber seal is damaged.

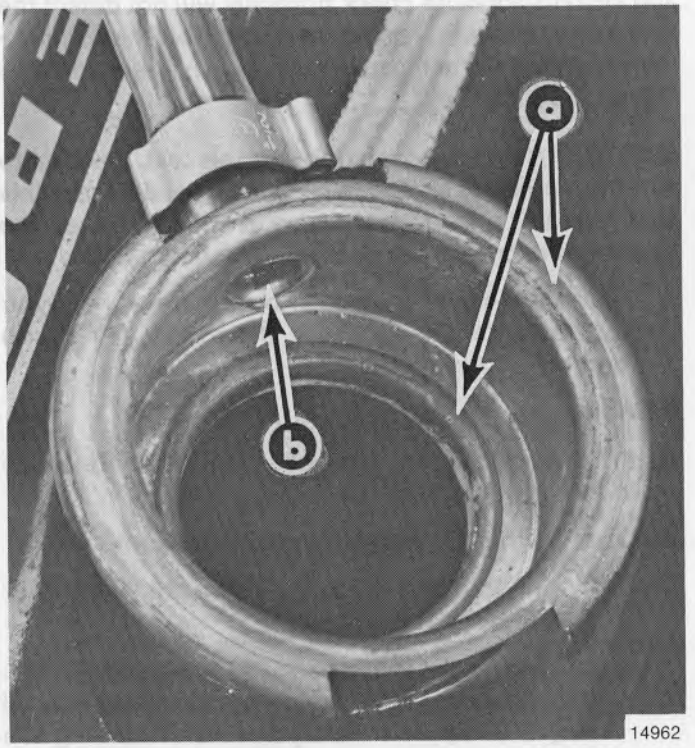


a - Rubber Seal
b - Gasket
c - Locking Tabs (1 Hidden)

4. Using a cooling system pressure tester, test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap MUST relieve pressure between 11 and 17 psi (76-117 kPa) and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall with these limits.

Pressure Testing Pressure Cap

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



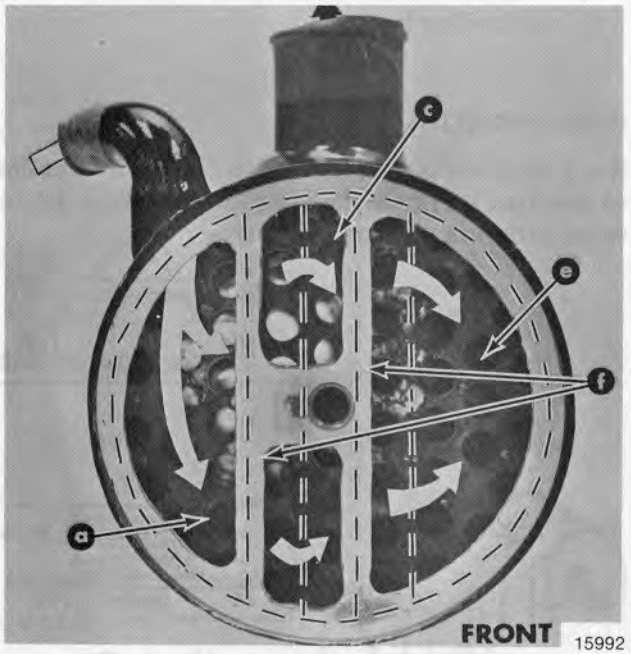
a - Inspect for Damage
b - Clean Coolant Recovery Passage

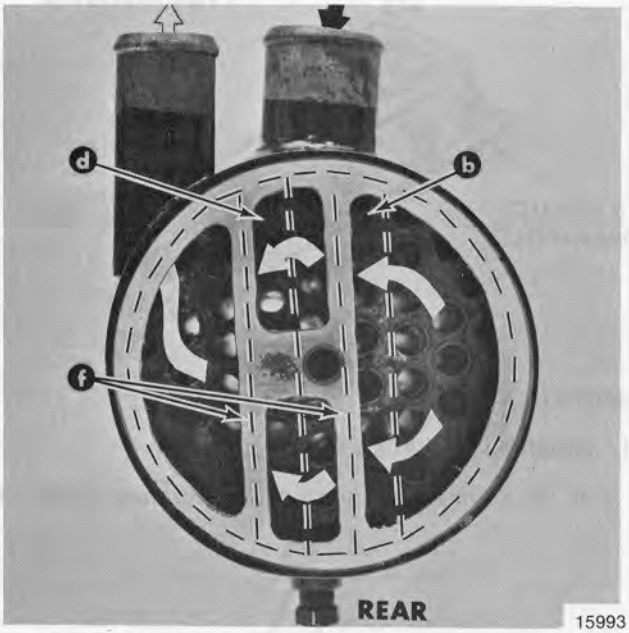
5. Reinstall cap on reservoir.

Heat Exchanger Repair

1. Freezing the seawater circuit usually forces the end castings out of the shell. These castings can be cleaned, reinserted properly and brazed in place by a radiator shop.

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.





a - 17 Tube Flow to Rear
b - 8 Tube Flow to Front
c - 9 Tube Flow to Rear
d - 8 Tube Flow to Front
e - 17 Tube Flow to Rear
f - The Two Ribs On Each End Are Solid

Closed Cooling Coolant Flow

Seawater Flow

98643 End Casting Placement
4" (102 mm) Dia.

IMPORTANT: The end castings direct the seawater flow through the heat exchanger. If they aren't installed correctly, the water takes a short cut and two-thirds (or more) of the exchanger is not used.

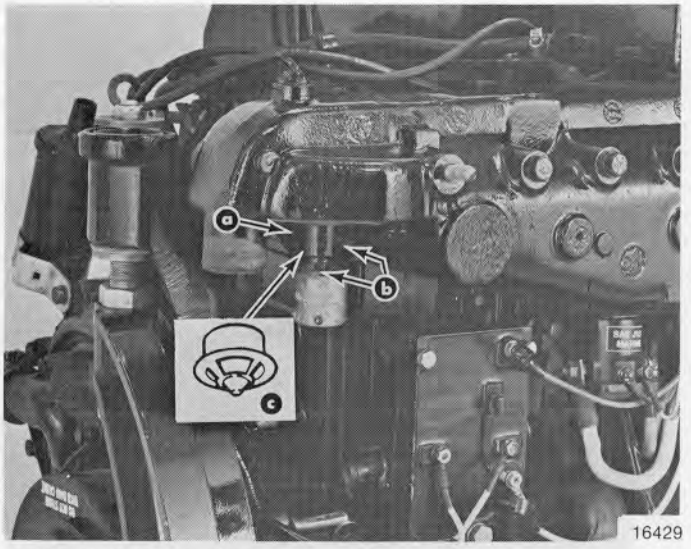
MCM engines with a 4" (102mm) dia. heat exchanger, seawater passes through exchanger five (5) times before leaving.

2. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than 3 tubes.
3. Nipples and drains, that have been broken off the heat exchanger, can be re-attached by brazing.

Thermostat

REMOVAL

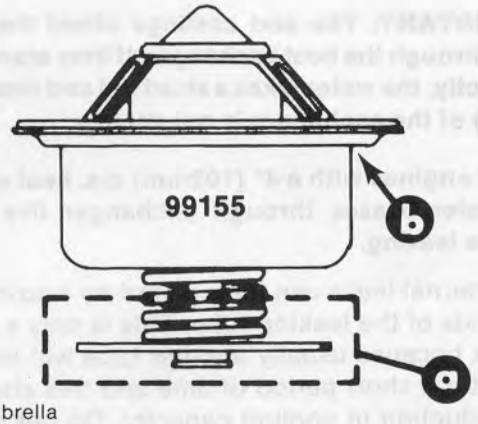
1. Drain coolant from exhaust manifold.
2. Remove thermostat as shown.



a - Thermostat Housing
b - Remove Bolts (2)
c - Remove Thermostat

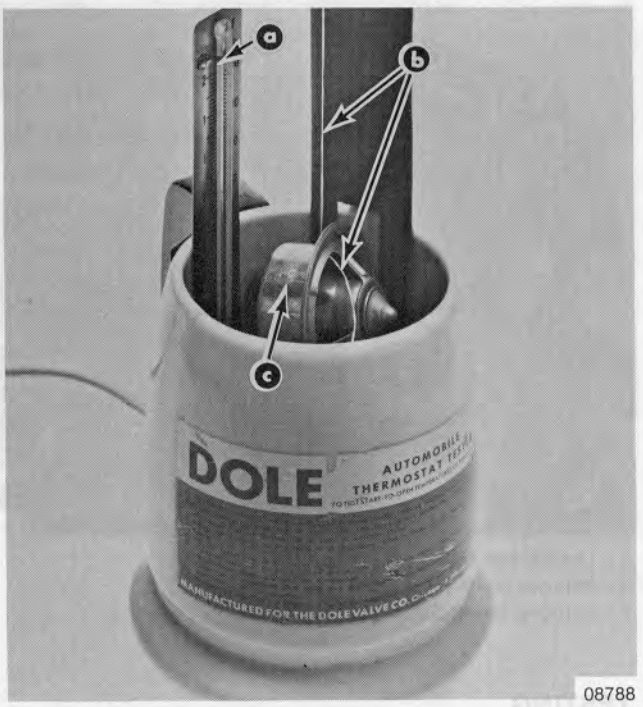
TESTING

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Check for light leakage around thermostat valve. Light leakage indicates thermostat should be replaced. (A small amount of leakage at 1 or 2 points around valve perimeter is acceptable.)
3. Check condition of umbrella. If damaged, replace thermostat.



a - Check Umbrella
b - Check for Light Leakage

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:
   a. Fill tester to within 1" (25mm) of top with tap water, do not use distilled water.
   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



a - Thermometer
b - Nylon String
c - Thermostat

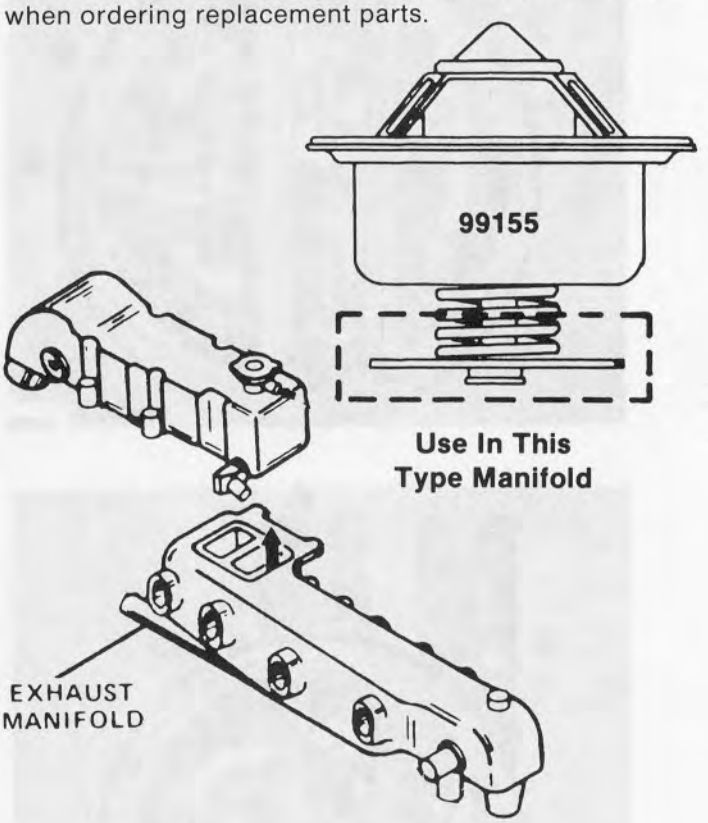
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

IMPORTANT: When performing Steps (d) and (e), water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at 155° - 162° F (68° - 72° C). Thermostat must be completely open at 182° F (83° C).
   e. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   f. Replace a thermostat that fails to meet all of the preceding tests.

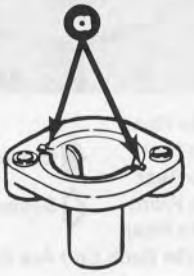
IDENTIFICATION

Because there is a difference in operation and design of the two thermostats offered, care must be taken when ordering replacement parts.



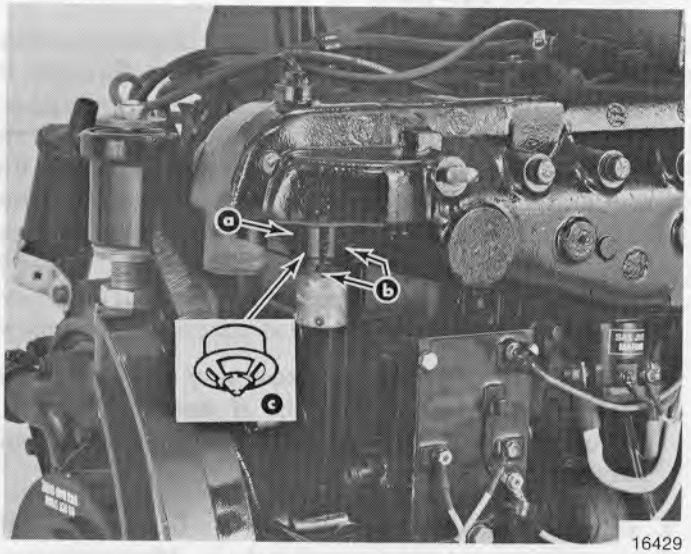
INSTALLATION

1. Clean all gasket surfaces.
   a. Slots must be clean or engine may overheat.



a - Slots

b. Install thermostat with umbrella up.



16429

a - Thermostat Housing - Coat Both Sides of New Gasket with Perfect Seal
b - Torque Bolts to Specifications
c - Thermostat

2. Refill closed cooling section as outlined in "Changing Coolant", see Index.

⚠CAUTION
Do not operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

3. Start engine and inspect for leaks.

Changing Coolant

COOLANT RECOMMENDATION

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

⚠CAUTION
Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in closed cooling section at any time.

Listed below are the current brands of permanent type anti-freeze solutions that are approved for use in MerCruiser engines. Do not mix the new anti-freeze solution with the old solution or it will cause small particles to form in the coolant. These small particles can settle in the heat exchanger and restrict coolant flow. Drain and flush the old anti-freeze solution from the closed cooling system.

PRESTONE II
PEAK (Produced after January, 1981) or any brand anti-freeze solution that meets G.M. specification 1825M.

CHANGE INTERVALS

The old coolant should be drained and flushed from the closed cooling system at least every two (2) years or whenever exhaust gases have entered into the system.

DRAINING PRECAUTIONS

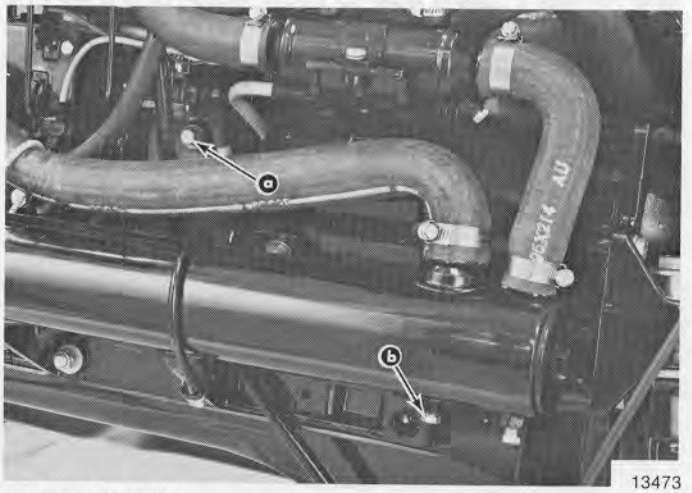
⚠WARNING
Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that drain holes are not blocked.

IMPORTANT: If possible, place a container under drains to prevent coolant from draining into boat.

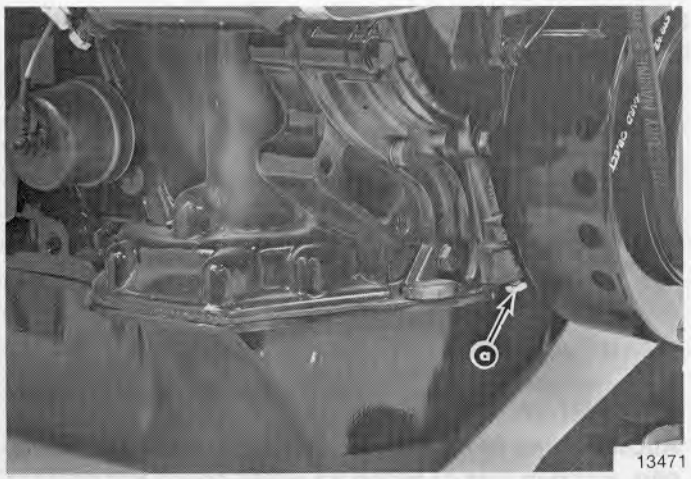
IMPORTANT: Refer to "Draining Precautions", in this section, before proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Remove drain plugs as shown.
4. Remove coolant recovery reservoir from bracket and pour out coolant.
5. After coolant has drained completely, coat threads of all drain plugs and reinstall.
6. Clean system as outlined in "Cleaning System".
7. Refill system as outlined in "Filling Closed Cooling System".



13473

a - Drain Plug (1)
b - Drain Plug (1)



a - Drain Plug

Stern Drive Unit Seawater Pickup Pump

Refer to appropriate drive, Service Manual.

Cleaning System

CLOSED COOLING SECTION

Closed cooling section of Closed Cooling System should be cleaned at least once every 2 years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Manufacturer's instructions, which accompany particular cleaner, always should be followed.

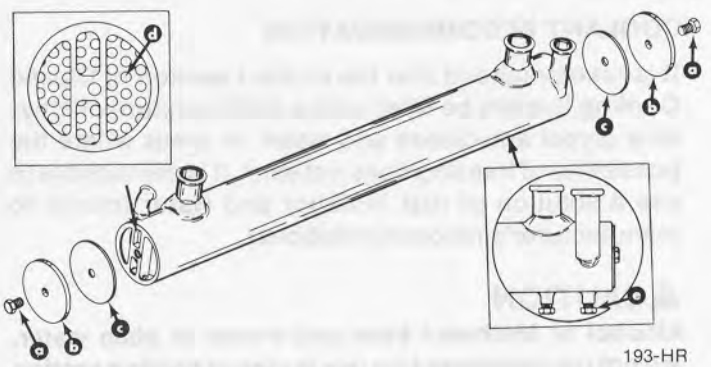
If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hook-up and flushing procedure.

SEAWATER SECTION

Cooling efficiency of an engine with Closed Cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every 2 years or whenever decreased cooling efficiency is suspected, as follows:

IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Perfect Seal and reinstall.
2. Remove bolts, which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger.
3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Using new gaskets (and sealing washers, some models), install end plates as shown.
5. Start engine and inspect cooling system for leaks.



a - Bolt - Torque to Specifications
b - End Cap
c - New Gasket - Do Not Use Perfect Seal
d - Clean Tubes
e - Seawater Drain Plug - Coat with Perfect Seal

Filling Closed Cooling Section

IMPORTANT: See "Specifications" for approximate closed cooling system capacity.

1. Fill closed cooling section with coolant thru reservoir filler neck until coolant solution is 1" (25mm) below filler neck.

⚠CAUTION

Do not operate engine without water flowing thru seawater pickup pumps, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

Engine should be as level as possible to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

Models with belt driven seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.

2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to reservoir, as required, to maintain coolant level 1" below filler neck.
3. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill reservoir to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on reservoir.
6. Remove cap from coolant recovery reservoir and fill to "Full" mark with coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat step 4.

IMPORTANT: Engine overheating is often due to air being trapped in fresh water section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

8. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
9. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

Out of Season Storage

CLOSED COOLING SECTION

Closed cooling section of closed cooling system should be kept filled year around with recommended coolant solution. Do not drain closed cooling section for storage. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol anti-freeze and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

SEAWATER SECTION DRAINING PRECAUTIONS

IMPORTANT: If the possibility of freezing exists, seawater section must be drained to prevent freeze damage to cooling system and engine. Seawater section also should be drained if boat is to be stored for an extended period of time, to prevent corrosion damage.

⚠CAUTION

Cooling system, must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

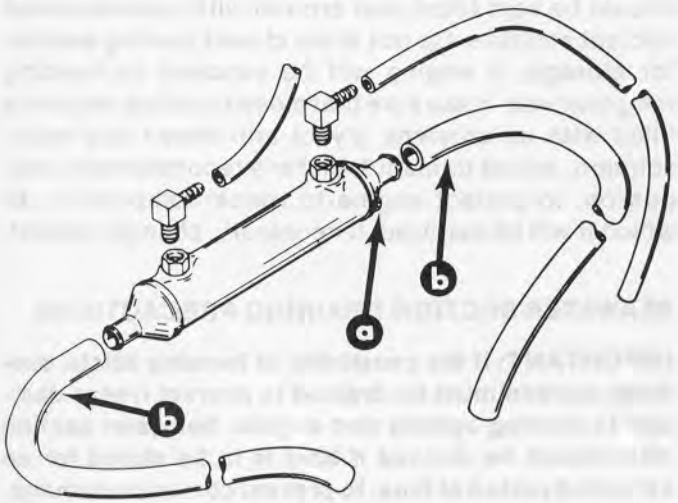
⚠CAUTION

If boat is in the water, water inlet valve (is so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

IMPORTANT: To prevent threads in elbows from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: If possible, place a container under drains to prevent water from draining into boat.

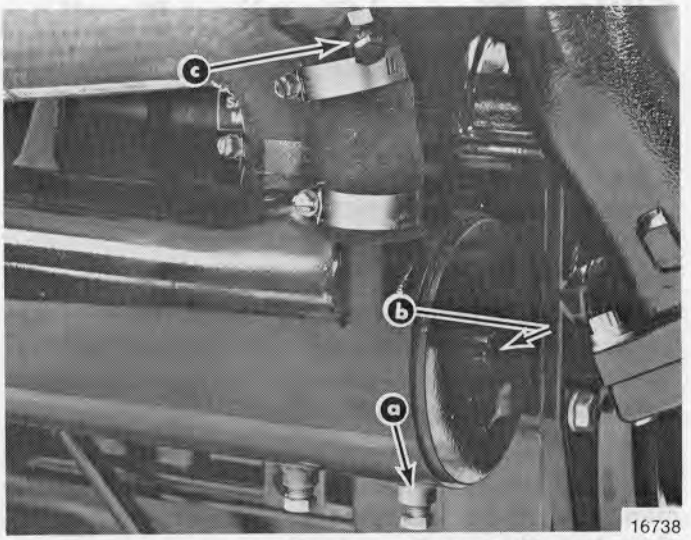


a - Remove Drain Plug
b - Cooler Without Drain Plug - Remove Hoses, Lower to Drain

Power Steering Fluid Cooler (if Equipped)

IMPORTANT: Refer to "Draining Precautions", in this section, before proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.
3. Remove heat exchanger end caps (to ensure complete draining) and clean tubes as outlined in "Cleaning System".
4. After cooling system has drained completely, coat threads of drain plug with Perfect Seal and reinstall.



a - Remove Drain Plug (1) (Some Early Model 4" Dia. Heat Exchangers Did Not Have Drain Plug, End Caps Have to be Removed
b - Remove End Cap (Both Ends)
c - Remove Drain Plug (Power Steering Models Only)

Auxiliary Hot Water Heater Installation

⚠CAUTION

Do not operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged, and subsequent overheating damage may result.

When connecting a cabin heater or hot water heater to a MerCruiser engine, certain requirements must be met.

Supply hose (from engine to heater) and return hose (from heater to engine) must not exceed 5/8" (16mm) I.D.

Heater must be lower than the fill cap on the reservoir. If the heater is higher than the fill cap on the reservoir and some coolant is lost in the system, an air pocket may form in the closed cooling system. This, in turn, can cause the engine to overheat.

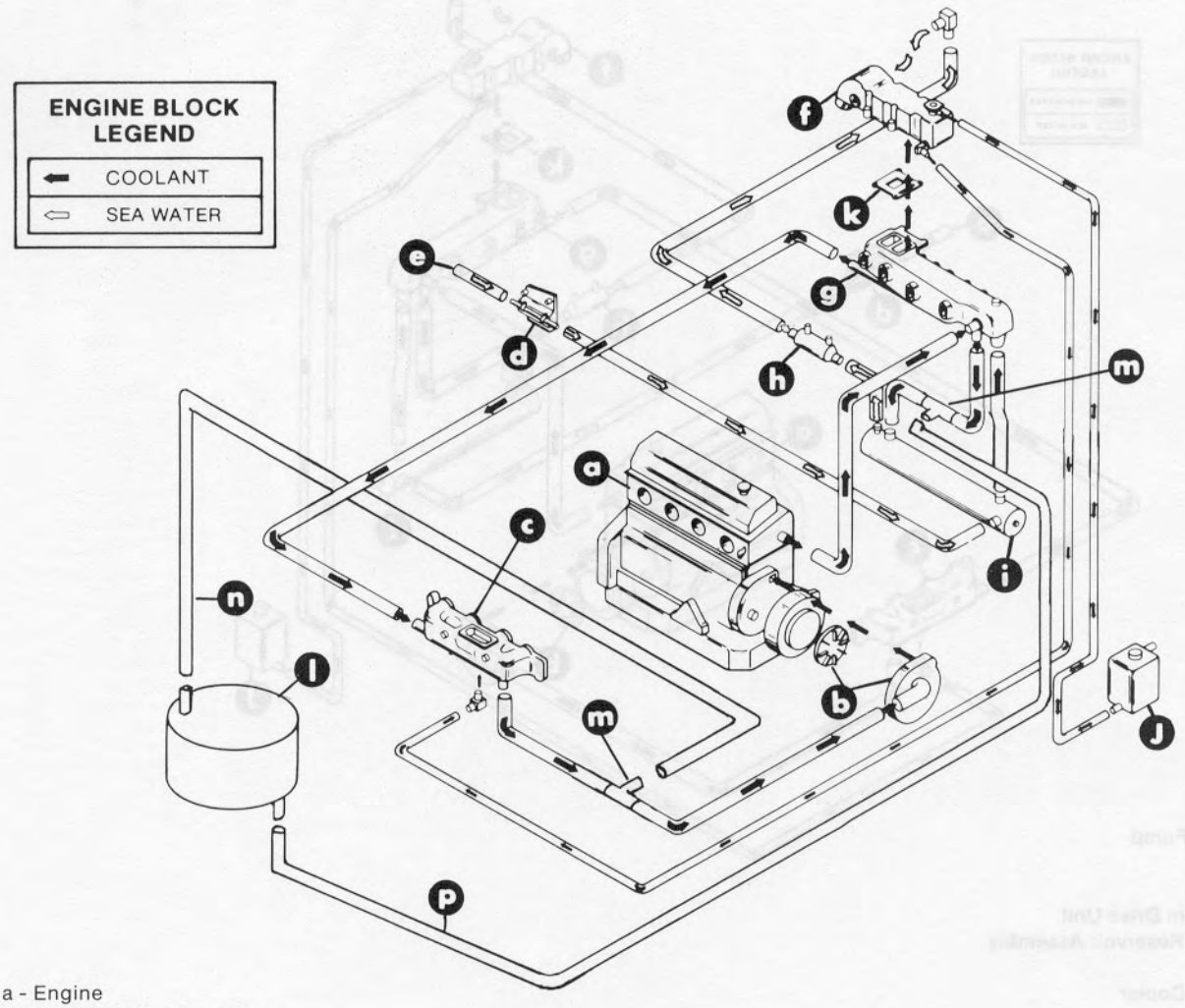
Make heater connections to MerCruiser engines only at locations shown.

Check complete system for leaks after heater is connected into cooling system.

Check for overheating condition (of engine) after heater is connected into cooling system.

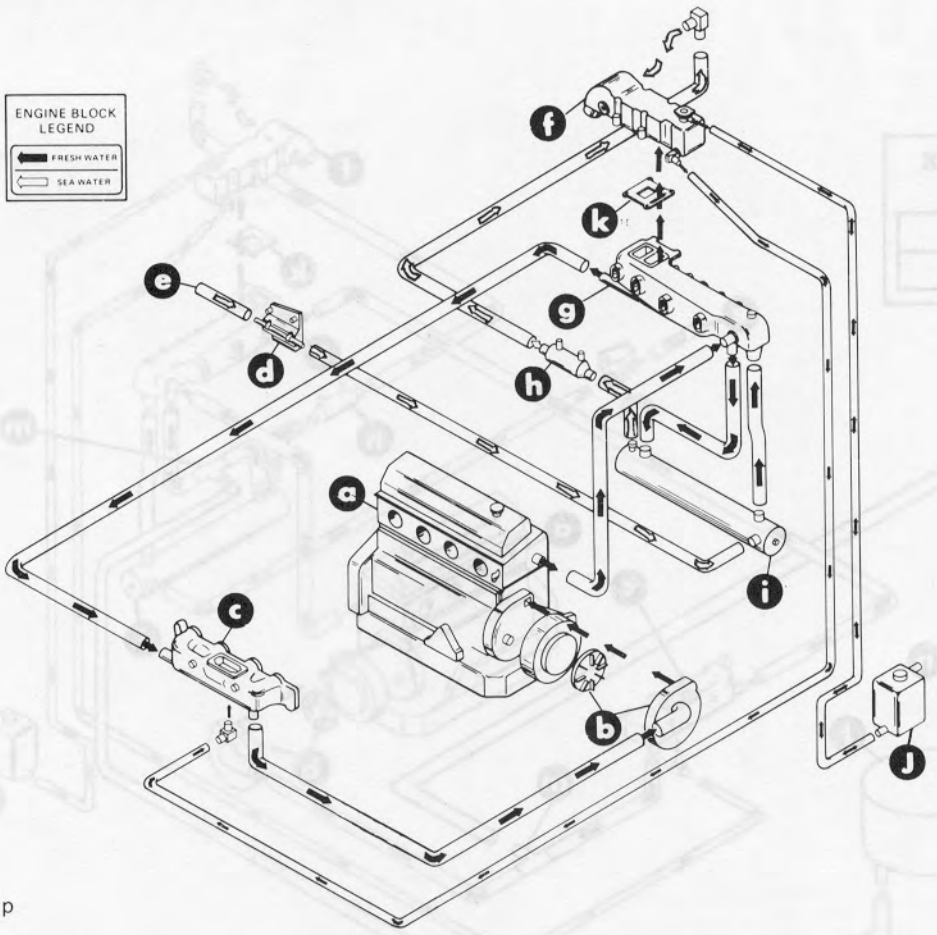
1. Connect auxiliary hot water heater into cooling system with "T" fittings and hose clamps (provided with kit), as shown. Cut approximately 3/4" (19mm) out of hoses to maintain proper hose configuration.
2. Support hoses, as required, to ensure that they do not rub or chafe against engine components.
3. Start engine and check for leaks.

Auxiliary Hot Water Heater

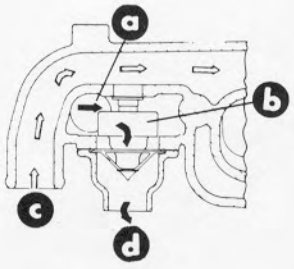


a - Engine
b - Engine Circulating Pump
c - Intake Manifold
d - Voltage Regulator
e - Seawater Inlet - From Drive Unit
f - Exhaust Elbow and Reservoir Assembly
g - Exhaust Manifold
h - Power Steering Oil Cooler
i - Heat Exchanger
j - Coolant Recovery Reservoir
k - Separation Plate
l - Water Heater
m - "T" Fitting
n - Outlet Hose
p - Inlet Hose

Cooling System Flow Diagrams

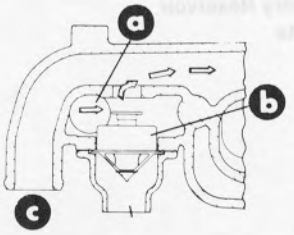


a - Engine
b - Engine Circulating Pump
c - Intake Manifold
d - Voltage Regulator
e - Seawater Inlet - From Drive Unit
f - Exhaust Elbow and Reservoir Assembly
g - Exhaust Manifold
h - Power Steering Oil Cooler
i - Heat Exchanger
j - Coolant Recovery Reservoir
k - Separation Plate



a - From Engine
b - Thermostat
c - From Heat Exchanger
d - To Heat Exchanger

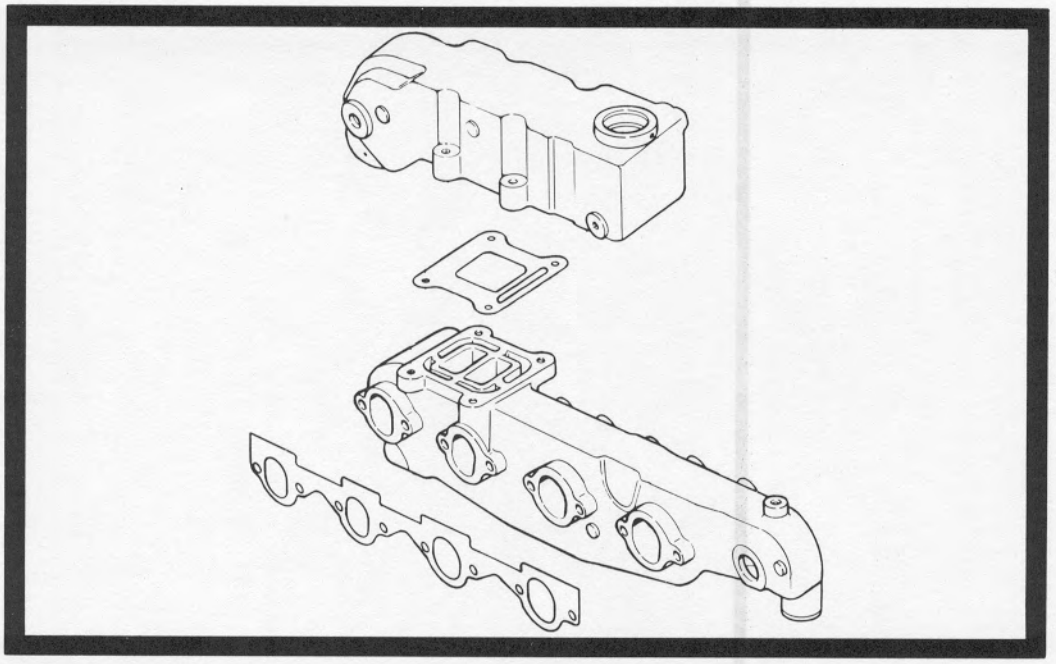
Coolant Flow Through Exhaust Manifold and Thermostat Housing Assembly with Thermostat Open



a - From Engine
b - Thermostat
c - From Heat Exchanger
d - To Heat Exchanger

Coolant Flow Through Exhaust Manifold and Thermostat Housing Assembly with Thermostat Closed

EXHAUST SYSTEM



CLOSED COOLED MODELS

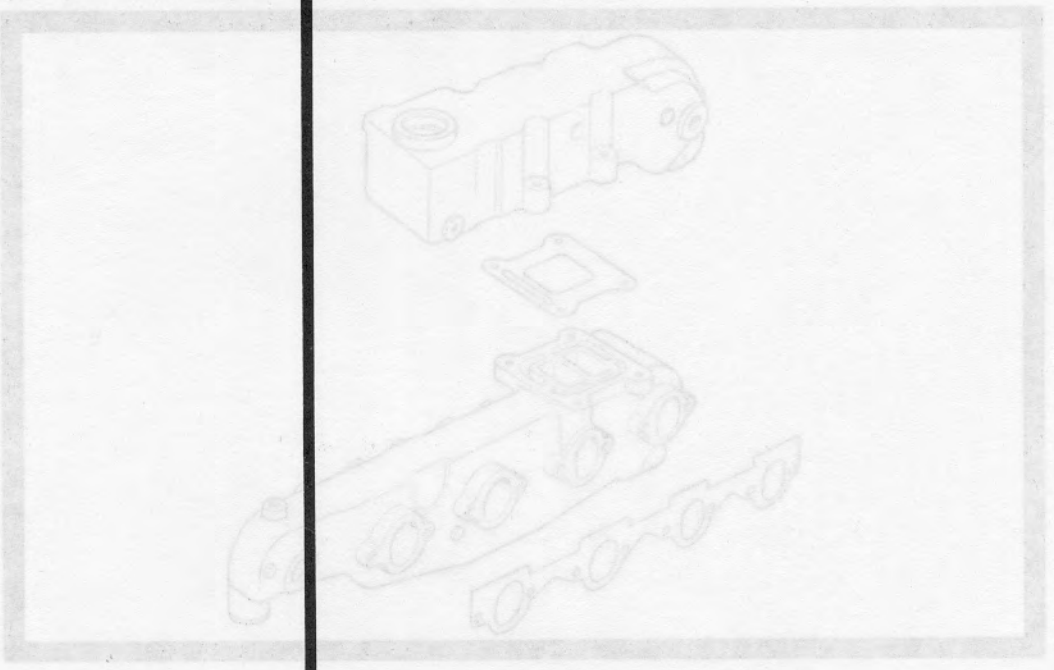
6

B

mercruiser
STERN DRIVES & INBOARDS

INDEX

	Page
Exhaust System Requirements	6B-1
Exhaust Manifold/Elbow	6B-1
Torque Specifications	6B-1
Sealants	6B-1
Cleaning and Inspection	6B-1
Removal	6B-2
Disassembly	6B-2
Reassembly	6B-2
Installation	6B-3
Exhaust Component and Shutter	6B-3
Torque Specifications	6B-3
Sealant	6B-3
Upper Exhaust Pipe and Shutter Replacement	6B-3
Lower Exhaust Pipe Replacement	6B-4



Exhaust System Requirements

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

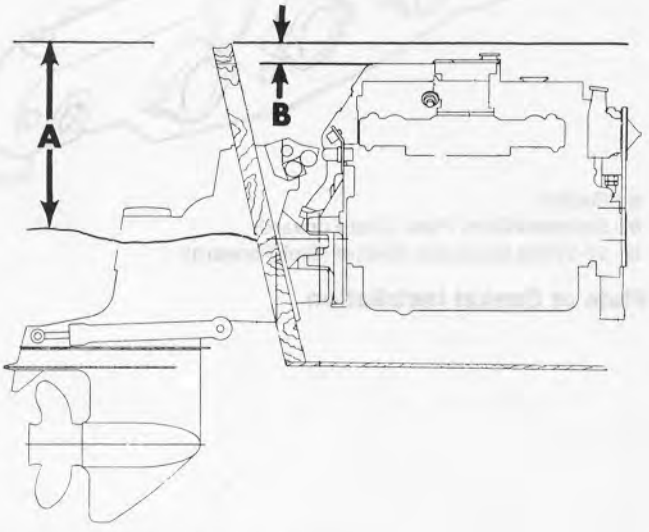
The exhaust system for the engine was designed to meet a wide variety of boating applications. Exhaust Riser Kits, therefore, are not available for these two models.

The engine must not be used in boats which do not meet the minimum 13 in. (33cm) exhaust elbow height requirement.

To ensure that exhaust (elbow) requirement has been met by the boat builder, perform the following:

1. With boat at rest in-the-water and maximum load aboard, take measurements "A" and "B" (shown below).

2. Measurement "A" minus "B" must be 13 in. (33cm) or more.



a - Measure Waterline to Top of Transom
b - Measure Highest Point on Exhaust Elbow to Top of Transom

Exhaust Manifold/Elbow

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Hose Clamps	Securely
Exhaust Elbow/Reservoir	30 (41)
Exhaust Manifold	25 (34)
Thermostat Housing	20 (27)

Sealants

SEALANTS	
92-32609-1	Quicksilver Loctite
92-34227--1	Quicksilver Perfect Seal

Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Perfect Seal before reinstalling.

5. Check for cracks.
6. To test manifold body for leaks, block off plates, plugs, or short hoses with plugged ends must be used. One block off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.
   Using new gaskets, install elbow/reservoir assembly to manifold body. Using hoses, plugs and clamps, seal all openings that coolant would flow thru (seawater inlet and outlet do not have to be plugged). Pressure check the assembly, using automotive radiator tester. Follow tool manufacturer's instructions.

REMOVAL

1. Disconnect battery cables from battery.
2. Drain engine coolant and seawater.
3. Disconnect wire from temperature sending unit.
4. Disconnect all hoses and exhaust bellows from manifold assembly.

NOTE: You may have to drain engine oil and remove dipstick tube to remove manifold.

5. Remove wiring harness clamps from manifold.
6. Remove shift cables from shift plate assembly.
7. Disconnect engine harness shift cutout switch wires.
8. Remove exhaust manifold fasteners. Remove manifold assembly and discard gasket.

DISASSEMBLY

IMPORTANT: To test manifold and reservoir for leaks, refer to "Cleaning and Inspection" before disassembly.

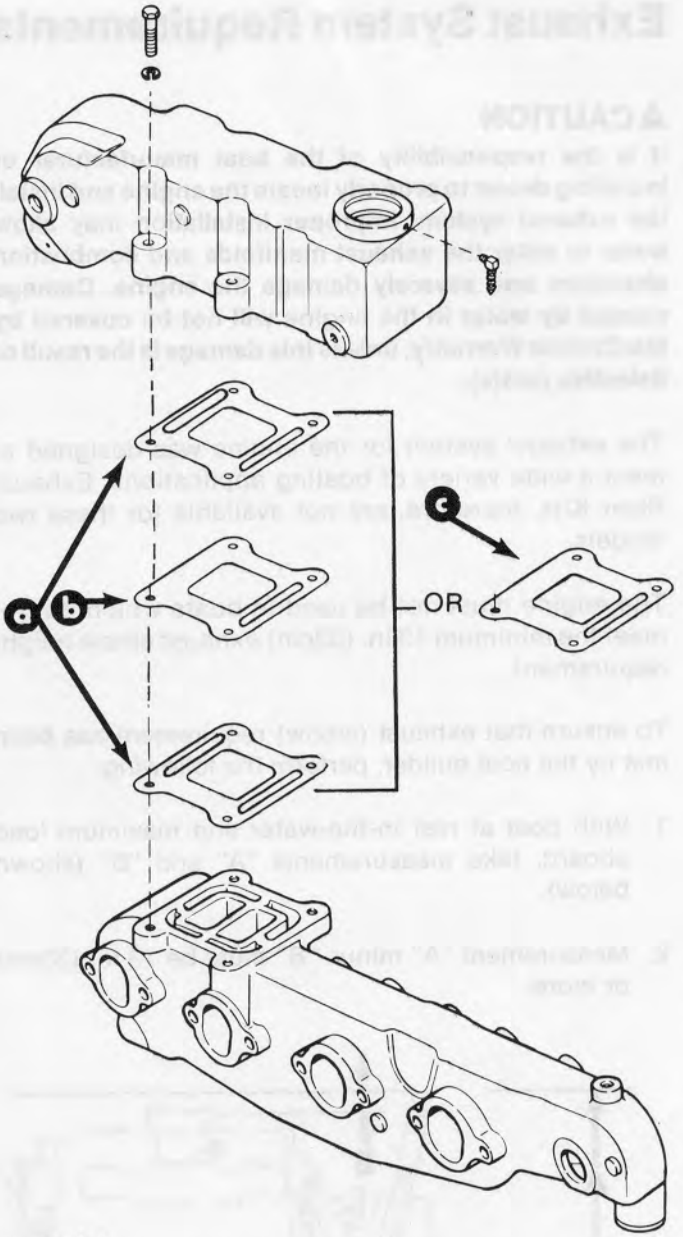
1. Remove exhaust elbow/reservoir assembly.
2. Remove thermostat housing and thermostat.
3. Remove temperature sender and brass plug.
4. Refer to "Cleaning and Inspection".

REASSEMBLY

1. If manifold body requires replacement, transfer parts from old body.
2. If exhaust elbow/reservoir requires replacement, transfer parts from old assembly.
3. Using new gaskets, install exhaust elbow/reservoir assembly to manifold. Torque to 30 lbs. ft. (41 N.m).

IMPORTANT: Gaskets and plate must be installed as shown, or leak will occur.

4. Using Perfect Seal on threads, install temperature sender and brass plug.
5. Using new gasket, install thermostat and thermostat housing. Torque to 20 lbs. ft. (27 N.m).



a - Gasket
b - Stainless Steel Plate (Slot Forward)
c - 27-97542 Separator Gasket (Slot Forward)

Plate or Gasket Installation

INSTALLATION

1. Using a new gasket, position manifold assembly onto cylinder head and install lockwashers, nuts and bolts. Torque to 25 lbs. ft. (34 N.m).

NOTE: If removed, install dipstick tube to oil pan and to support clamp located on exhaust manifold fastener bolt. Fill engine to proper oil level.

2. Connect all hoses and exhaust bellows to manifold assembly. Tighten clamps securely.
3. Connect engine harness wire to temperature sender.
4. Install wiring harness clamps.
5. Reconnect engine harness shift cutout switch wires to terminal block.
6. Connect and adjust shift cables as outlined in MerCruiser IR-IMR Service Manual 90-12934.
7. Fill closed cooling system to proper coolant level.
8. Pressure check the cooling system, using automotive radiator tester. Follow tool manufacturer's instructions.
9. Start engine and check for leaks.

Exhaust Component and Shutter

Torque Specification

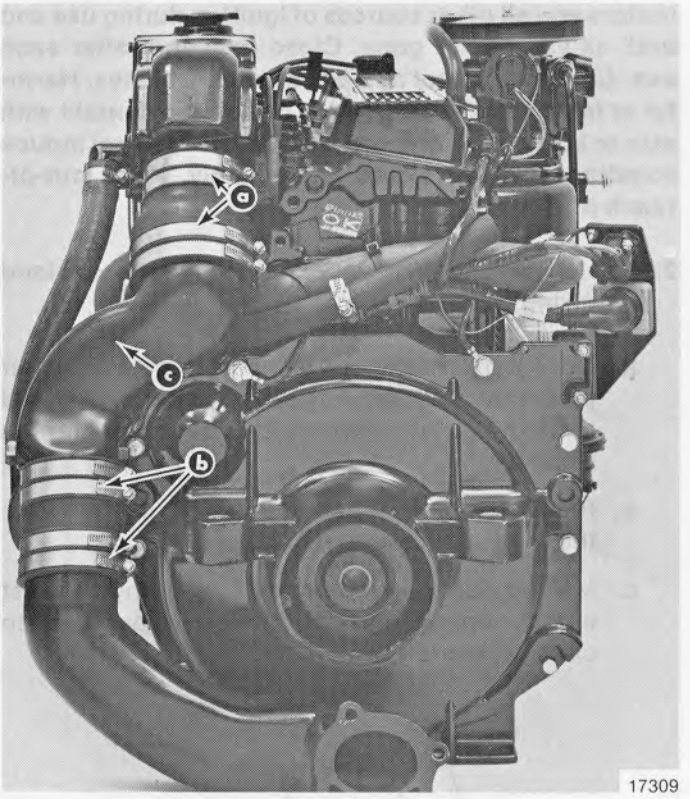
Fastener Location	Lbs. Ft. (N.m)
Exhaust Pipe to Gimbal Housing	20-25 (27-34)
Hose Clamps	Securely

Sealant

SEALANT	
92-86166	Quicksilver Bellows Adhesive

Upper Exhaust Pipe and Shutter Replacement

1. a. Loosen exhaust bellows clamps.
   b. Loosen connector hose clamps.
   c. Remove upper exhaust pipe.



17309

a - Exhaust Bellows Hose Clamps
b - Connector Hose Clamps
c - Upper Exhaust Pipe

⚠WARNING

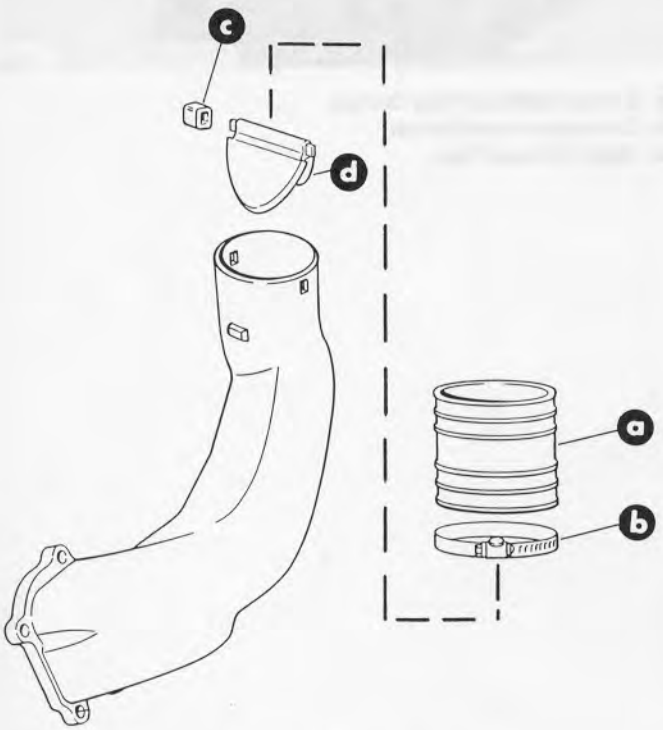
Extremely flammable! Vapors from Bellows Adhesive may cause flash fire or ignite explosively. Prevent buildup of vapors. Open all windows and doors. Use only in cross-ventilation. Keep away from heat, sparks and open flame. Do not smoke. Extinguish all flames and pilot lights and turn off stoves, heater, electric motors and all other sources of ignition during use and until all vapors are gone. Close container after each use. Contains Toluol and petroleum distillates. Harmful or fatal if swallowed. Avoid prolonged contact with skin or breathing of vapors. If swallowed, do not induce vomiting. Call physician immediately. Keep out-of-reach of children.

2. Replace shutter in lower exhaust pipe as explained following:

   a. Coat both mating surfaces of hose and lower pipe with Bellows Adhesive. Allow to dry and slide hose on lower pipe. Tighten clamps securely.

   b. Place clamps over bellows and connector hose; then, install upper exhaust pipe.

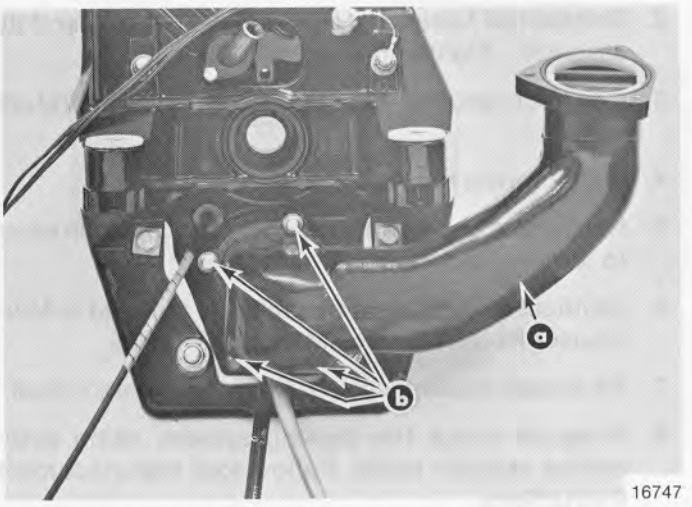
   c. Making sure all clamps are contacting exhaust elbow, upper pipe and lower pipe, tighten clamps securely.



a - Connector Hose - Remove to Change Shutters
b - Clamps (2)
c - Grommet (2)
d - Shutter - Opens Downward

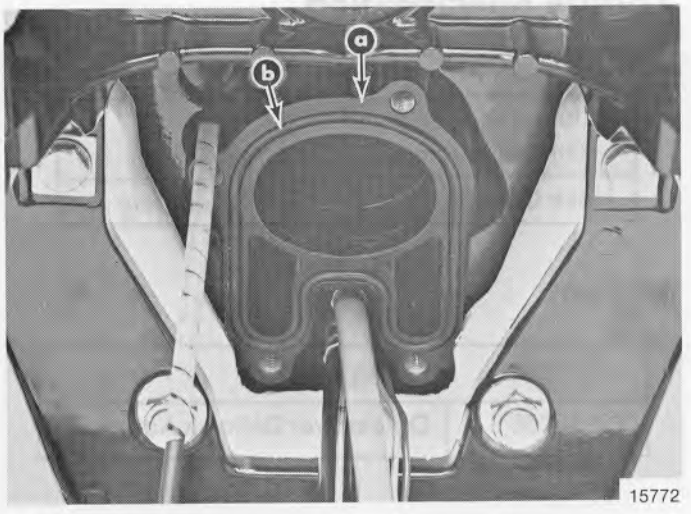
Lower Exhaust Pipe Replacement

1. Remove stern drive unit. (Refer to MerCruiser IR-IMR Stern Drive Service Manual 90-12934.)
2. Remove engine; remove upper exhaust pipe.
3. Remove lower exhaust pipe screws and lockwashers.



a - Lower Exhaust Pipe
b - Screws and Lockwashers (4 Each)

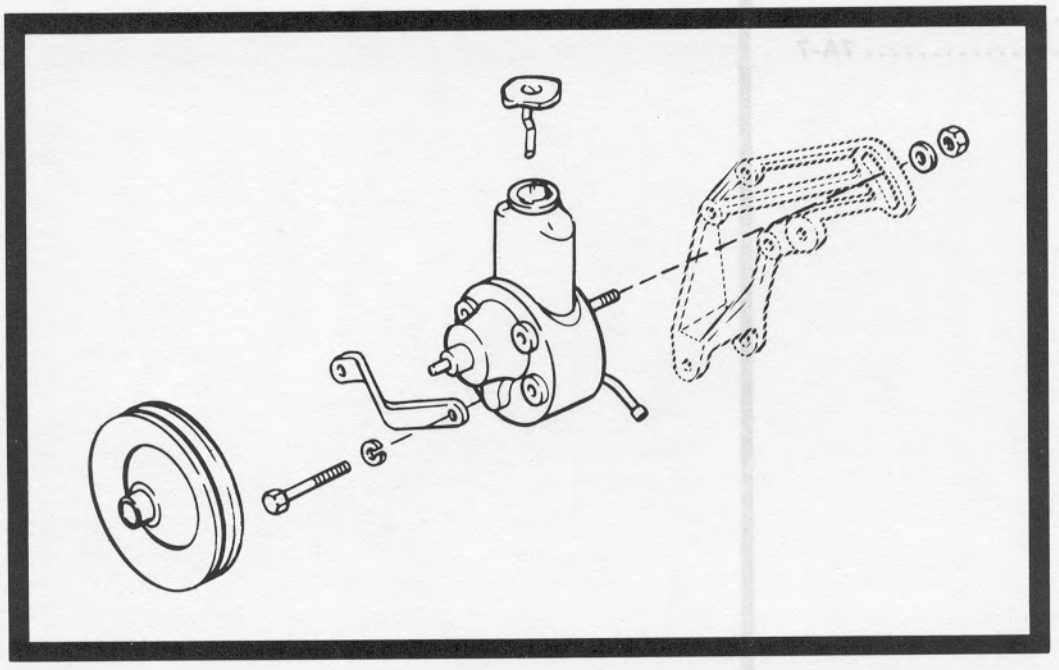
4. a. Remove lower exhaust pipe and "O" ring.
   b. Clean mating surfaces on pipe and gimbal housing.
   c. Place "O" ring in groove of gimbal housing.



a - Mating Surface
b - "O" Ring

5. Reinstall lower exhaust pipe, using screws and lockwashers. Torque screws to 20-25 lbs. ft. (27-34 N.m). Make sure "O" ring remains seated in groove.
6. Reinstall engine; reinstall upper exhaust pipe.
7. Install stern drive unit.

POWER STEERING

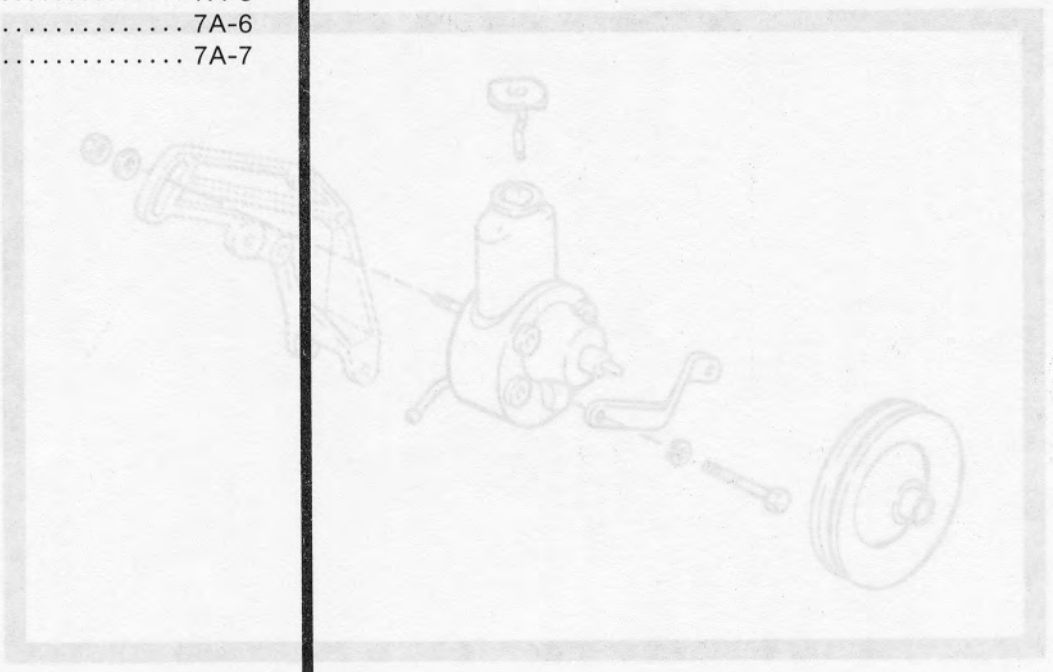


mercruiser
STERN DRIVES & INBOARDS

A 7

INDEX

	Page
Torque Specification	7A-1
Tools/Sealants/Fluids	7A-1
Precautions	7A-1
Checking Fluid Level	7A-1
Filling and Air Bleeding Power Steering System	7A-2
Drive Belt Tension Adjustment	7A-3
Important Service Information	7A-3
Metric Pumps	7A-3
Pump Pulley Replacement	7A-3
Pump Repair	7A-4
Power Steering Pump and Cooler Replacement	7A-4
Priority Valve Kit (79691A1)	7A-6
Installation	7A-6
Installing Reservoir	7A-6
Installing Priority Valve	7A-7



Torque Specification

Fastener Location	Torque
Pump Mounting Bracket to Engine	25 Lbs. Ft. (34 N.m)

Tools/Sealants/Fluids

MERCURY MARINE SPECIAL TOOLS	
91-93656A1	Pulley Installer

KENT-MOORE SPECIAL TOOLS	
Can be ordered from: Kent Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J-25034	Pulley Removal Tool

SEALANTS/FLUIDS	
92-34227	Quicksilver Perfect Seal
92-90100	Power Trim & Steering Trim
	Automatic Transmission Fluid (ATF)
	Type F, Automatic Transmission Fluid
	Dexron or Dexron II

Precautions

⚠WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION

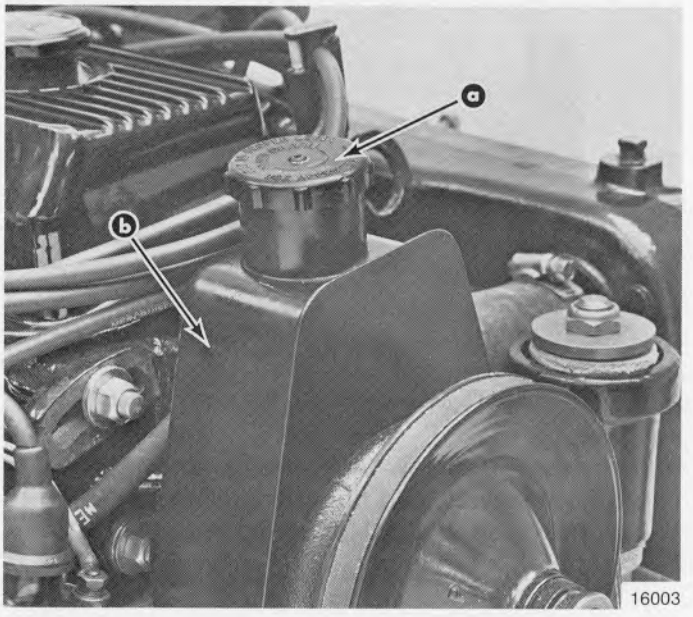
Do not pry on Power Steering pump when adjusting belt tension. Serious damage may result.

Checking Fluid Level

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

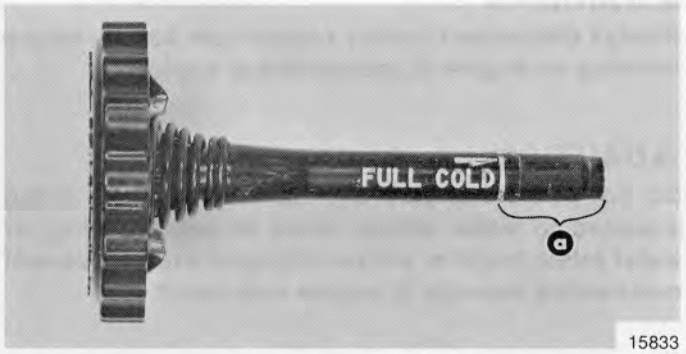
WITH ENGINE COLD

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.



a - Fill Cap
b - Power Steering Pump

3. Level should be between "Full Cold" mark and bottom of dipstick.

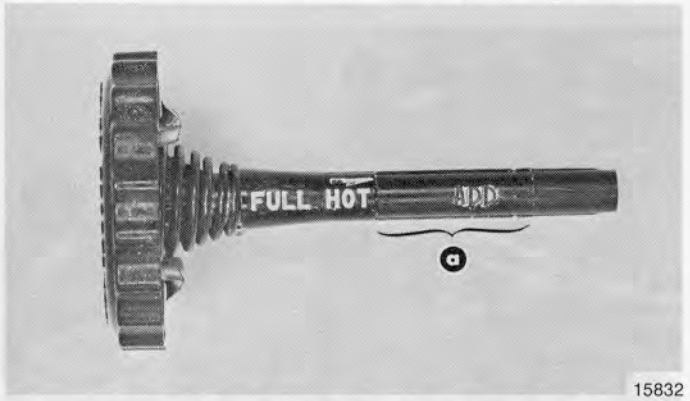


a - Recommended Fluid Level Engine Cold

4. If fluid level is low but, still visible in pump reservoir, add fluid, thru fill cap opening to bring level up to "Full Cold" mark on dipstick. Do not overfill.

WITH ENGINE WARM FROM OPERATION

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.
3. Level should be between the "Full Hot" mark and "Add" mark on dipstick.



a - Recommended Fluid Level - Engine Warm from Operation

4. If level is low (below "Add" mark), but still visible in pump reservoir, add fluid thru fill cap opening to bring level up to "Full Hot" mark on dipstick. Do not overfill.

Filling and Air Bleeding Power Steering System

IMPORTANT: Power Steering system must be filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Remove shipping cap from Power Steering pump and check fluid level with dipstick attached to cap. Add fluid as required, to bring up to correct level.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then, recheck fluid level and add fluid, if necessary.
3. Install fill cap.

⚠CAUTION

Do not operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse; then, check fluid level and add fluid, as required, to bring level up to "Full Hot" mark on dipstick. Do not overfill. Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and Power Steering fluid must be hot to accurately check fluid level.

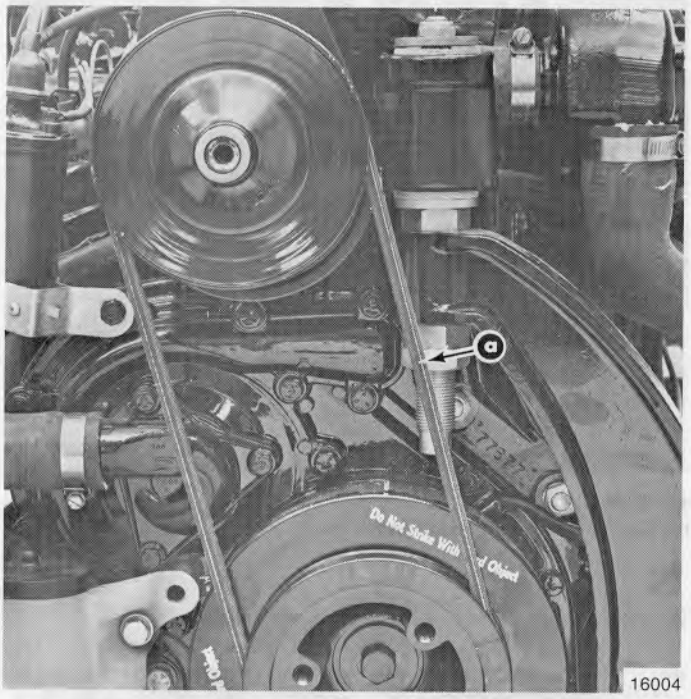
6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Drive Belt Tension Adjustment

IMPORTANT: Refer to Precautions in this section before proceeding.

IMPORTANT: Do not pry on pump body.

1. Install drive belt on pulleys.
2. Pivot pump to attain tension.
3. Tighten retaining bolts.



a - Check Belt Tension Here

4. Check belt tension using either of 2 methods, following and readjust pump, if necessary, to obtain proper belt tension.
   a. Using a strand tension gauge, take gauge reading at mid-point of Power Steering pump belt. Gauge should read 75-95 lbs. (334-423 N.m).
   b. Check belt tension by pushing down on upper strand of belt at belt mid-point. Belt should depress 1/4 in. (6 mm).

Important Service Information

METRIC PUMPS

Power Steering pumps are of metric design. All hose fittings and attaching hardware also are metric.

Part Number for the Power Steering pump mounting studs is 16-41878.

"O" ring P/N 25-89879 is used to seal the metric Power Steering pump pressure hose.

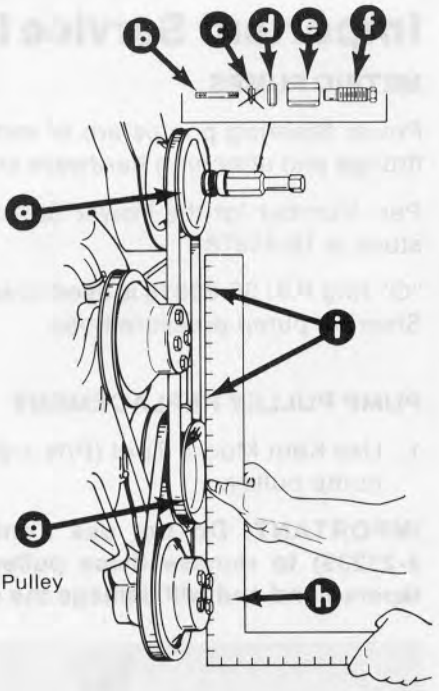
PUMP PULLEY REPLACEMENT

1. Use Kent Moore Tool (P/N J-25034) to remove the pump pulley.

IMPORTANT: Do not use Kent Moore Tool (P/N J-21239) to remove these pulleys. This tool has a tapered end and will damage the shaft.

a - Kent Moore Pulley Removal Tool J-25034

2. Install pulley, as follows, using Pulley Pusher Assembly 91-93656A1, and a long straight edge:
   a. Place pulley on pump shaft.
   b. Thread stud all-the-way into pump shaft. Place bearing over stud. Do not use spacer from kit.
   c. Thread nut onto shaft. Thread shaft (and nut) all-the-way onto stud.
   d. Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
   e. Check pulley installation for correct alignment.



a - Power Steering Pump Pulley
b - Stud
c - Do Not Use Spacer
d - Bearing
e - Nut
f - Shaft
g - Crankshaft Pulley (Shown) or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

Pump Repair

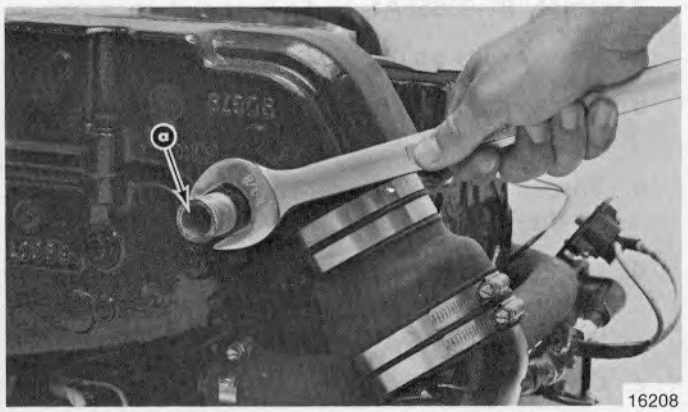
NOTICE
For pressure checks and repairs refer to appropriate "Stern Drive Service Manual".

Power Steering Pump and Cooler

REPLACEMENT

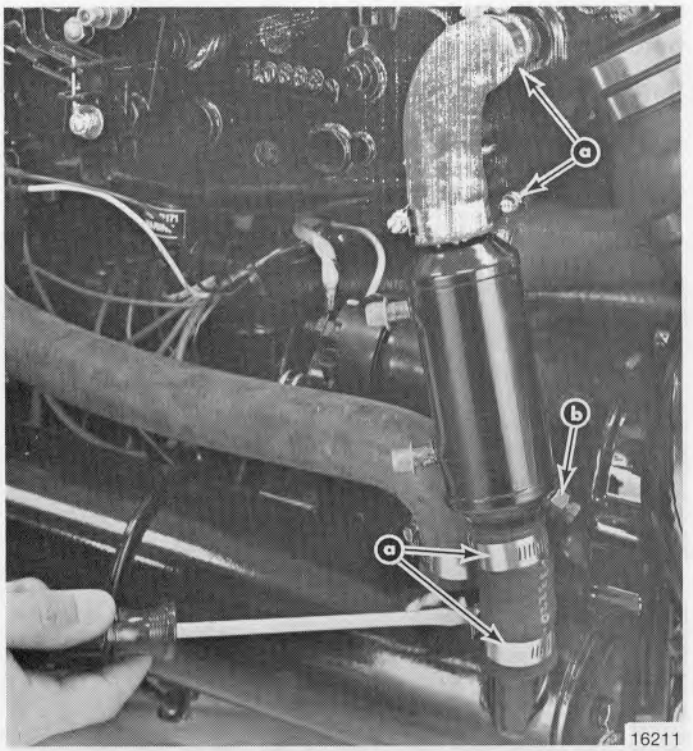
IMPORTANT: Retain all hardware for future installation.

1. Apply sealer to hose coupling and install.



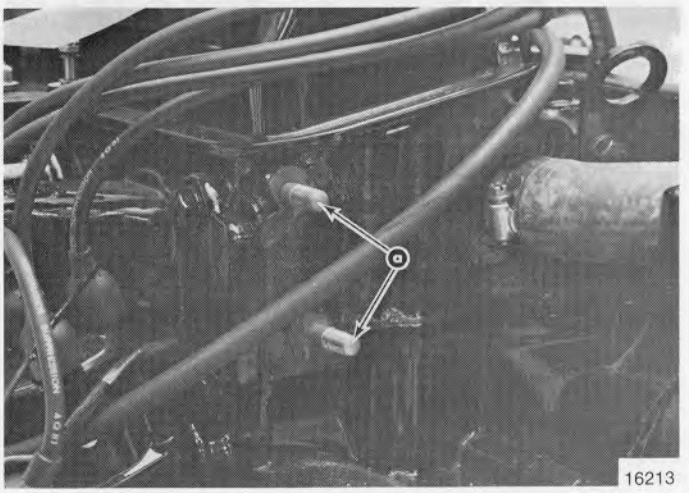
a - Straight Hose Coupling

2. Install fluid cooler.



a - Hose Clamps - Tighten Securely
b - Cooler Drain Plug Must Face Down

3. Install studs.



a - 1-5/8" (41mm) Long Studs

4. Remove paint from mounting surface.

a - Remove All Paint (Making Sure Surface is Smooth)

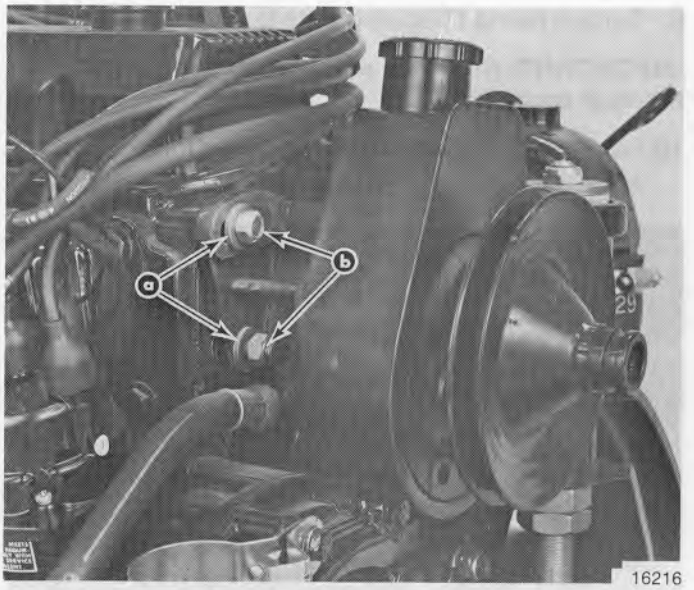
5. **IMPORTANT: Hydraulic hose must be routed before securing pump.**

   Route hydraulic hoses.

a - Motor Mount (Hose Routed Behind)
b - Exhaust Manifold Hose (Hose Routed Behind)
c - Hydraulic Hose

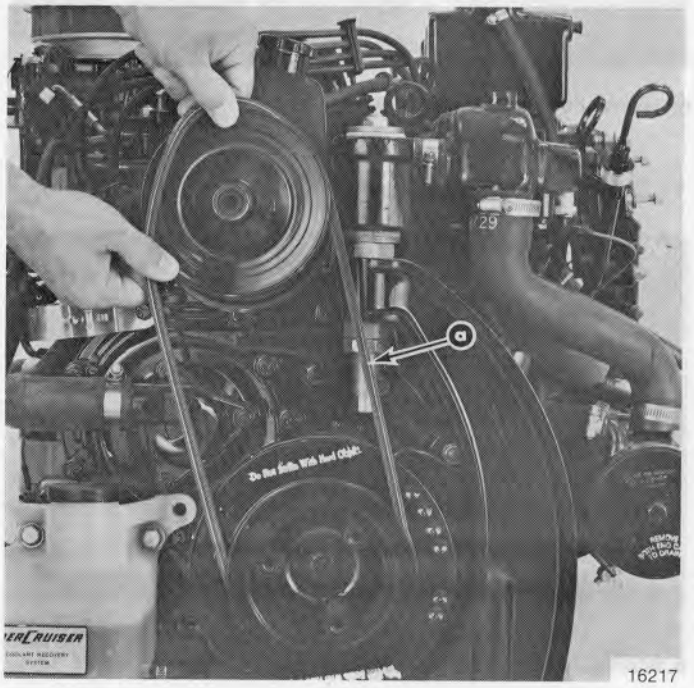
d - Hydraulic Hose Routed Between Distributor and Coil

6. Install and fasten pump.



a - 1/8" (3mm) Thick Washers
b - 3/8" x 24 Nuts (Do Not Tighten At This Time)

7. Install drive belt.



a - Drive Belt

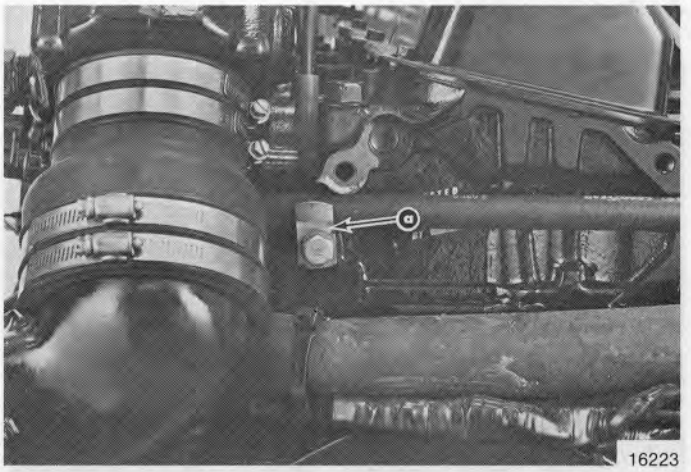
8. Adjust drive belt. See "Drive Belt Tension".
9. Torque pump attaching nuts to 25 lbs. ft. (34 N.m).

IMPORTANT: Retorque pump attaching nuts after 20 hours of operation.

10. Reconnect hydraulic hoses and tighten clamps securely.

a - Hydraulic Hoses and Clamps

11. Support hydraulic hoses.



a - J-Clips

12. Fill and air bleed Power Steering system.

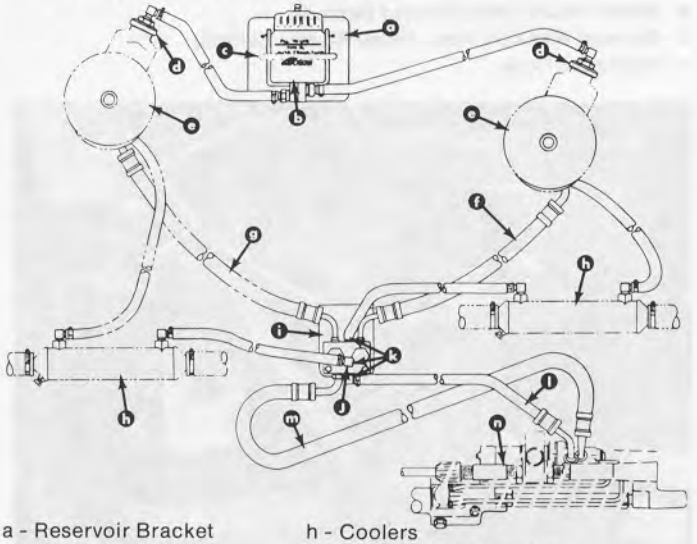
Priority Valve Kit (79691A1)

IMPORTANT: This kit is for use on Dual Installations where both engines are equipped with Power Steering pumps, coolers, related hardware and hoses and one Transom Assembly is equipped with Power Steering.

INSTALLATION

Installing Reservoir

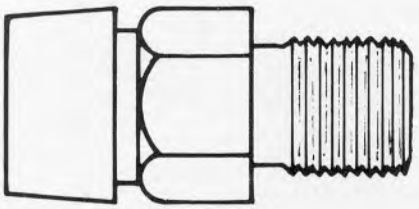
1. Mount reservoir bracket to transom with 2 screws (from kit) halfway between the 2 Power Steering pumps in a location that affords both accessibility and visual inspection of reservoir oil level. Be sure that location is at least 6" (150mm) higher than pumps and is far enough away from any obstruction that might prevent mounting of priority valve. Priority valve must be mounted no closer than 2" (51mm) from bottom of reservoir.



a - Reservoir Bracket
b - Bottle Reservoir
c - Retainer Spring
d - Cap Assemblies
e - Power Steering Pumps
f - Secondary Pressure Line
g - Primary Pressure Line
h - Coolers
i - Priority Valve Bracket
j - Priority Valve
k - 90° Elbows
l - Return Hose from Kit
m - Pressure Hose from Kit
n - Power Steering Control Valve

2. Position bottle reservoir in mounting bracket and secure with retainer spring from kit.

IMPORTANT: The two-way check valve is required for cold weather operation below 40° F (4° C). Remove vent from reservoir cover and replace with two-way check valve, if conditions require. (It is not necessary to replace vent if temperature is above 40° F [4° C], unless reservoir overflows during operation.)



Two-Way Check Valve

3. From bulk hose (supplied with kit; hose without fittings), cut 2 hoses of sufficient length to extend from bottom of reservoir to fill caps on pumps. Allow enough extra hose for routing and installation of cap assemblies.
4. Secure hoses with sta-straps to keep them below reservoir and away from excessive engine heat and moving parts.
5. Position hose clamps over ends of hoses, connect one end of each hose to reservoir and other end of each hose to a cap assembly. Tighten hose clamps securely. Do not fasten caps to pumps at this time.

Installing Priority Valve

1. Install valve mounting bracket with 5/16-9 x 2" (51mm) lag bolts and washers (from kit) in a central position under reservoir. Be sure that location will allow 2" (51mm) or more between priority valve and reservoir when priority valve is mounted to bracket.
2. Install 90° elbows (from kit) into priority valve (at locations marked "T"), using location of coolers, and Power Steering control valve as guides for direction of elbows. Use liquid pipe joint sealer to seal connections and tighten fittings securely.
3. Secure priority valve to bracket with 5/16-18 x 2-3/4" hex head bolts, nuts and washers from kit. Tighten securely.
4. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from Power Steering cooler to respective fitting on priority valve.
5. Position hose clamps over ends of hoses and connect one end of each hose to its repective Power Steering cooler and the other end to fitting on priority valve. Use sta-straps to keep hoses away from excessive engine heat and moving parts.
6. Install hose (fitting on one end only, from kit) to Power Steering control valve. Route hose to priority valve, then cut hose to length, position hose clamp over end and install hose to its respective fitting.
7. Install hose (with fittings on both ends, from kit) between Power Steering control valve and "S" (large) position on priority valve.
8. Install both pressure hoses (leading from pumps) to "S" (small) locations on priority valve, as shown.

2. Position bottle reservoir in mounting bracket and secure with retainer spring from kit.

IMPORTANT: The two-way check valve is required for cold weather operation below 40° F (4° C). Remove vent from reservoir cover and replace with two-way check valve, if conditions require. (It is not necessary to replace vent if temperature is above 40° F [4° C], unless reservoir overflows during operation.)

Two-Way Check Valve

3. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from bottom of reservoir to fill caps on pumps. Allow enough extra hose for routing and installation of cap assemblies.

4. Secure hoses with sta-straps to keep them below reservoir and away from excessive engine heat and moving parts.

5. Position hose clamps over ends of hoses, connect one end of each hose to reservoir and other end of each hose to a cap assembly. Tighten hose clamps securely. Do not fasten caps to pumps at this time.

Installing Priority Valve

1. Install valve mounting bracket with 5/16-9 x 2" (51mm) lag bolts and washers (from kit) in a central position under reservoir. Be sure that location will allow 2" (51mm) or more between priority valve and reservoir when priority valve is mounted to bracket.

2. Install 90° elbows (from kit) into priority valve (at locations marked "T"), using location of coolers, and Power Steering control valve as guides for direction of elbows. Use liquid pipe joint sealer to seal connections and tighten fittings securely.

3. Secure priority valve to bracket with 5/16-18 x 2-3/4" hex head bolts, nuts and washers from kit. Tighten securely.

4. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from Power Steering cooler to respective fitting on priority valve.

5. Position hose clamps over ends of hoses and connect one end of each hose to its respective Power Steering cooler and the other end to fitting on priority valve. Use sta-straps to keep hoses away from excessive engine heat and moving parts.

6. Install hose (fitting on one end only, from kit) to Power Steering control valve. Route hose to priority valve, then cut hose to length, position hose clamp over end and install hose to its respective fitting.

7. Install hose (with fittings on both ends, from kit) between Power Steering control valve and "S" (large) position on priority valve.

8. Install both pressure hoses (leading from pumps) to "S" (small) locations on priority valve, as shown.